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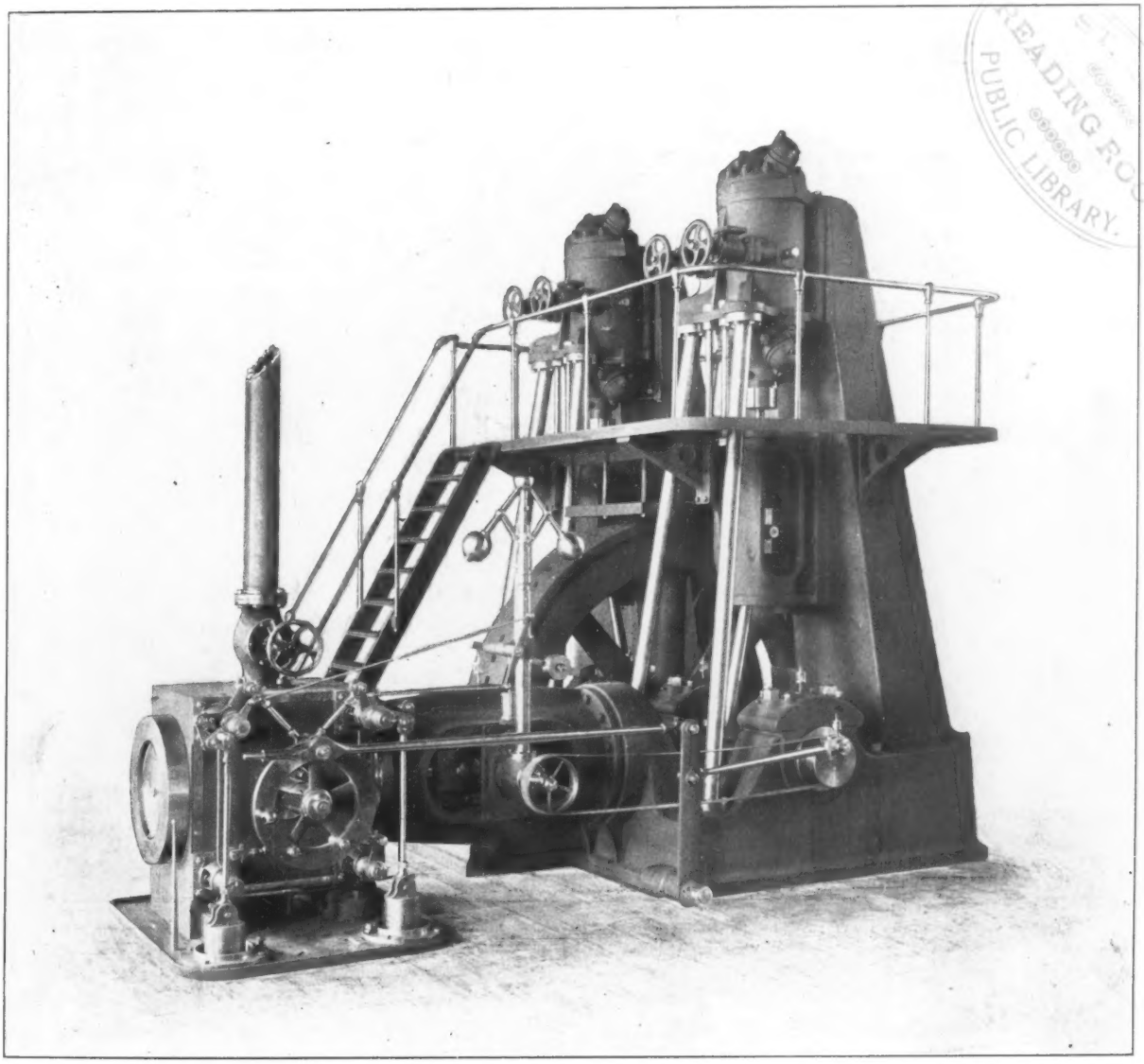

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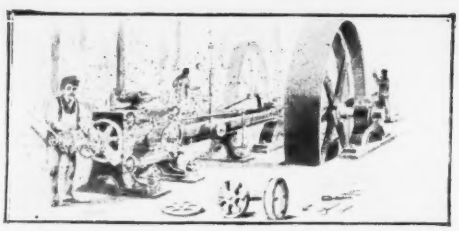

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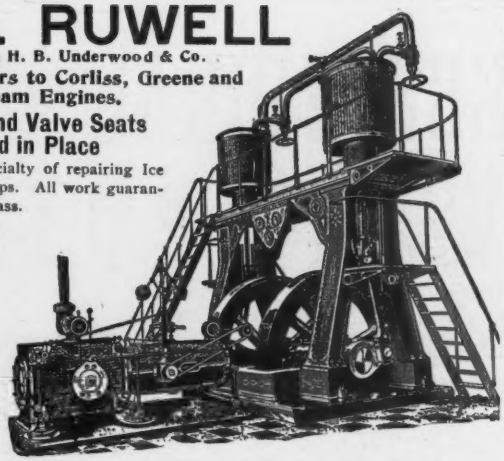

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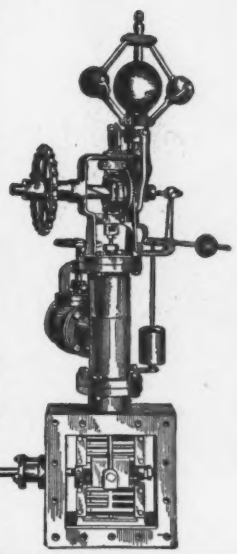

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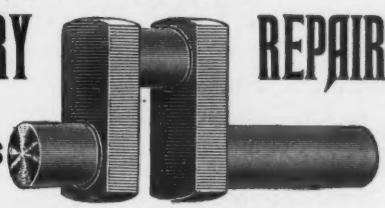

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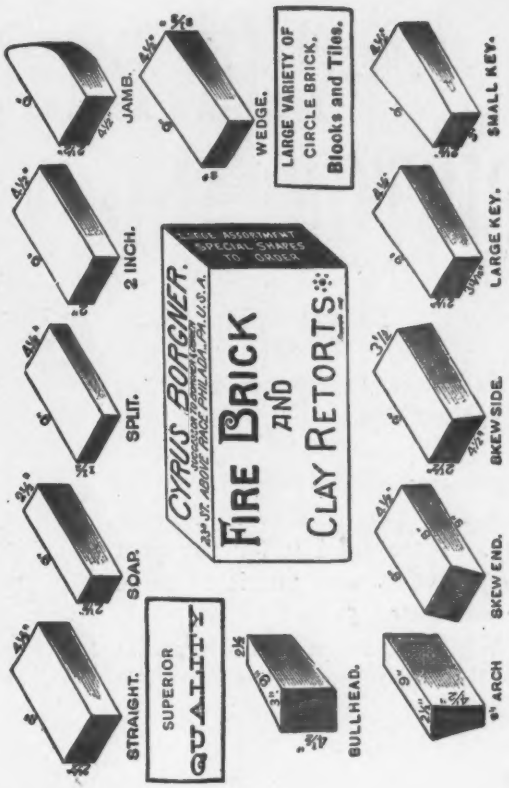

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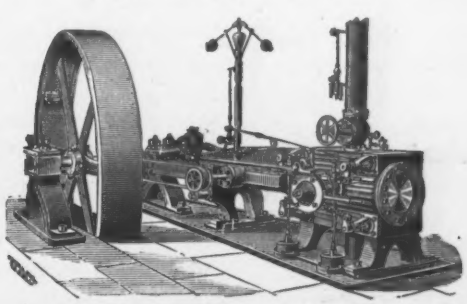

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The Practical Engineer

THE
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Devoted to the Interests of Stationary Engineers.

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Mechanical Stokers

The introduction of mechanical means of feeding furnace fires with fuel, contrary to general opinion, is not a new invention by any means. The possibilities of such a device were recognized as far back as 1785 when James Watt designed and built a device to operate mechanically which would push the coal, after it became coked at the front end of the grate, back towards the bridge. This suggestion of Watts' was seized upon by a great number of inventors, and numerous patents were taken out in England for devices with a similar intent, namely—mechanical firing.

The non-success of any of these devices at that time is undoubtedly attributable to the fact of their construction being crude, in that the wearing parts were practically inaccessible for making needed repairs. Further than this the moving parts were of such a complicated nature that the average fireman of that period could not be depended upon to take proper care of them. Hence for a long period the commercial and other valuable features of this method of firing lay dormant.

It finally devolved upon the American mechanic to further perfect apparatus to successfully overcome all the major difficulties which lay in the way of its adoption.

The mechanical stokers in use in this country are almost entirely of American design, and are well adapted for the service to which they are applied, whether for burning graded small coals or mine refuse, such as screenings or other unmarketable coal. A mechanical stoker is particularly suited to the burning of such refuse material, and instances are plentiful in which more steam was supplied when using bituminous slack or refuse coal in a furnace provided with an automatic stoker than the ordinary grate-surface supplied when using lump coal, hand-fired, the boilers and all other accessories being similar, this increase in performance being due to the constant supply of coal to the fire without any disturbing influences. The labor required for boiler attendance with a mechanical stoker is much less than that required for the ordinary flat grate of like capacity and burning similar fuel. The time consumed in cleaning a fire under a boiler provided with such a machine is claimed to be less than one-tenth than that required for similar work with ordinary furnaces.

Fuel economy is one of the claims persistently urged by makers of mechanical stokers, not that a furnace fed by machine will accomplish results different than if fed by hand under the best conditions, but hand-firing occurs at irregular intervals, and usually more coal is put on the fire than is necessary. A mechanical stoker, with continuous feed, will supply the coal as needed without disturbing the progress of the fire, not cooling it by an excess of coal, nor by the admission of cold air in the furnace by the opening of the fire-door.

The prevention of smoke by the use of a mechanical stoker is largely brought about by a uniform delivery of fuel to the grates, maintaining a high temperature at all times in the furnace and combustion chamber. This constant fuel supply, especially in the case of fine coal, permits the gradual distillation of the gases from the coal as it enters the furnace, and the automatic movement of the grates keeps the air spaces open, insuring the combination of the oxygen of the air with the hydro-carbon gases in the furnace, and the complete utilization of the latter in heat-making.

The direct question of economy in fuel through the use of the mechanical stoker is often disputed, but even presuming that the consumption of fuel is the same, we must give the machine the preference over the hand method.

First, for humanity's sake; who has watched a fireman cleaning his fires upon a mid-summer day as he stands before that fiery maw straining every nerve and muscle, huge beads of perspiration rolling from him like water as

he twists and pulls the red devils within, with his face half-averted in an endeavor to grasp a breath of air, and then to see him stagger back as he finishes, reeling and gasping, for the moment more dead than alive? Who indeed but will say that the mechanical stoker is a success?

Secondly, the ease with which coal can be handled from shutes direct to the hopper of the stoker, not only doing away with work of shoveling the coal, but overcoming its attendant evils—that of dust and dirt. And so we might go on and enumerate a manifold number of advantages, both great and small, to the user, wholly independent of fuel consumption.

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The World's Fair Commission —Improvements and Chances for Improvements

We note with pleasure that the St. Louis World's Fair Commission has made a departure from all precedent in the matter of making no charge for exhibit space. This is as it should be. Too often in the past it has been the custom for commissions of this sort to make of the Exposition a money-grabbing scheme, and in so doing they have lost sight entirely of the fact that to be consistent, the Exposition must become an educator of the people—to become as it were an ocular means of dissemination of the world's latest achievements in the commercial, mercantile and mechanical lines, irrespective of the inventor's financial ability to subscribe to a block of stock and contribute a frequently prohibitive tax for space.

Furthermore, the Exposition Company have decided to abolish charges for power, light and such facilities as may seem reasonably necessary for the best presentation and operation of a desirable exhibit. This programme cannot fail of acceptance as evidencing the proper attitude of a great international exposition toward the workshops of the world, and it now lies in the power of all, at a mediocre cost, to assist in making the Louisiana Purchase Exposition "par excellence" in the history of such events.

With the bars let down, so to speak, in such an exemplary manner, the world will have opportunity to study alike, the great and the small, the products of the individual as well as the corporations. Hence we may look to the St. Louis World's Fair to be indeed a World's Fair, combining as it must, under such conditions, a means of bringing before the public a line replete with the output of our brightest and strongest business men and mechanics, irrespective of their financial condition.

In one other point there is, as yet, vast room for improvement, and it is hoped that the Commission will see it in time; it is in the line of proper consideration for the trade journals. The trade journal has come to be the strongest feature of education in their respective lines that the country possesses, and it should be the desire and endeavor of the Louisiana Fair Commission to assist them to the utmost in their efforts to obtain pictures, data, etc., of the Fair and its intricacies, and not, as has already been the case in the past, retard their endeavors to gain such knowledge.

It will be well for the Exposition Company to abolish the extortion of money, usually permitted to be exacted by the Exposition Photograph Concessionaire of the trade representatives in taking photographs of exhibits, etc. Indeed, it might be said that the concessionaires in the past have been given the power to exclude, at their will, photos, etc., of matter of the greatest interest in their respective lines, because the "journal" or manufacturer refused (rightly too) to be "held up." We will be pleased to hear that the St. Louis Commission has abolished this objectionable feature, heretofore analagous to like projects, and place trade journals upon an equitable and independent footing in their search for the educational and industrial advantages of their Exposition.

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The Design and Quality of Boilers

Elsewhere in this edition we publish an article by W. H. Wakeman upon the selection of a boiler. This is a subject upon which there are numerous and diverse opinions, which is as it should be, for the conditions under which boilers have to work are multitudinous, hence the boiler giving satisfaction under one condition will not come anywhere near the standard in another. But, let us say right here is where it requires a display of the greatest acumen by the engineer as well as strength of character. First, a careful study of conditions must be made, not only of those at present existing, but of future contingencies ensuing. Secondly, he must possess the will-power, once a decision as to the requirements is made, to withstand the blandishments or other inducements extended to him by irresponsible and incompetent manufacturers of the style of boiler decided upon. There is no doubt that more than one-half of the boiler accidents are caused by poor workmanship and cheap construction. Thus it will be readily seen that not only is the design of the boiler to be considered, but also its construction.

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High Boiler Pressures

Professor Thurston, of Cornell, who is an expert on the steam engine, has been making experiments with steam pressure of 1000 pounds to the square inch, and thinks that these can safely be doubled in the course of time. These would greatly increase the efficiency of the steam engine, which is now well known to be very wasteful, even in its most economic forms. High pressures are produced by superheating the steam after it is generated, thus increasing its expansive power. In some of the steam automobiles the pressures go as high as 500 pounds. In the common steam boiler, as it is easy to see, a large fraction of the heat is lost in raising the water to the boiling point, and it is only the heat which the steam absorbs above that point that counts, all the rest being wasted.

Selecting a Boiler

By W. H. Wakeman.

There are so many different kinds of boilers manufactured at the present time, and so many claims are presented for them, that the man who intends to build a small plant, or replace one or two worn-out boilers with new ones, finds much difficulty in deciding which to buy. As the plant is not large, he does not think it necessary to hire a consulting steam engineer to draw the specifications, and superintend the work, but wishes to talk with different people, then decide for himself. While it is not within the province of this article to give all the information necessary in such cases, still it is intended to point out some things that should be taken into consideration, for if they are not, the results in every day practice will not be satisfactory.

Suppose that a boiler plant is to be installed in a place where land is not expensive, hence there is a plenty of room for it. Fuel is cheap and the water that must be used is not as pure as it ought to be, while only a moderate pressure is wanted.

For such a plant the two-flue boiler is superior to all others, for the following reasons: When new it will evaporate nearly as much water per pound of fuel burned, as more complicated types, and after it has been in use several years, it is possible to find conditions under which it will evaporate fully as much, because it can always be kept clean, while the more complicated kind is full of scale in some parts, and thickly coated with it in all others below the water line, if the same care is given both kinds.

Every part of it can be reached, therefore its exact condition may be known, while it is impossible to thoroughly inspect many others on account of tubes, stay bolts, braces and small compartments like the water leg of a locomotive boiler.

If such a boiler receives ordinary intelligent care, it will last for many years, and the cost of repairs will be low. The first cost of the two-flue boiler is moderate, which is the last point to be considered. In a place where land is expensive it is advisable to use boilers that occupy less room for a given power. Advocates of the vertical boiler claim that it occupies the least space of any that can be used, and when presenting this claim they show the small floor, or ground space required, but are careful not to mention that it calls for two stories in height.

If the boiler plant is to be located in a building that is used solely for this purpose, then the small ground space occupied is a good point, and the extra height is not objectionable, but if it is to be put in the lower part of a high building, the fact that it occupies two stories of said building becomes a detriment which must not be overlooked. If a high pressure is required, the vertical boiler can be made with a thick shell accordingly, which is not brought into contact with the fire, therefore heat is conducted through the thinner parts only. This is an important consideration in favor of this type, but it is one of the most difficult kinds to keep clean, where impure water must be used, that is in the market. Under such conditions it is not only advisable to install some form of apparatus for purifying water, but it is absolutely necessary to know that it will do the work required.

The manufacturers of such apparatus are always willing to put one in on trial, agreeing to take it away if it does not purify the water. This is all very well as far as it goes, but it does not go far enough. If it does fail, so that it becomes necessary to use the impure water in its natural state, a boiler should be selected that can be thoroughly cleaned, and this does not mean a vertical boiler with several hundred small tubes in it. After one of this kind has been installed it will generally not be taken out, because the water purifying apparatus proved a failure, but it will be used as long as possible, hence the whole matter should be thoroughly understood at the beginning.

A horizontal tubular boiler can be built so as to be safe when carrying 100 pounds pressure, without a complicated system of braces, and the tubes may be arranged in vertical and horizontal rows, and spaced wider apart so that nearly every part of it can be reached for cleaning. A boiler of this type may be installed in the basement of a building, where space is not valuable, as it only occupies one story in height, and it will evaporate about as much water per pound of coal as any boiler now in use. It will give better results than some other kinds. The greatest objection to this type is that many of them have exploded with disastrous results. While I do not dispute this fact, still it is well known that almost every one of these disasters might have been prevented, if reasonable care and skill had been exercised in operating them.

If the time ever comes when water-tube boilers are used as extensively in operating saw-mills and thresher outfits, as tubular, flue and locomotive boilers now are, and under like conditions, the confidence that many people now have in the water-tube boiler as a durable, safe and altogether desirable type, will be sadly shaken and broken.

There are hundreds of shell-boilers now in use under conditions that would have destroyed water-tube boilers long ago, and when one or more of them does fail, it is frequently charged against the type more than against the management which is directly responsible.

A certain steam user had a cast-iron safety boiler in use that he claimed was all that could be desired. A short time ago he moved his plant to another part of the city, but he did not take his old boiler with him, but left it to be sold for old iron. There is nothing remarkable about this, as any boiler might have been worn out after the same number of years in the the service, but the point that attracts attention is that in his new shop he installed a sectional boiler in which none of the parts are made of cast-iron. Others are doing the same thing, therefore it is well to profit by their example and avoid cast-iron boilers.

It is a small matter to replace a worn-out or broken part of some water-tube boiler, but when these parts fail frequently, causing numerous delays in running the plants, these small repair bills make a respectable total at the end of the year, and the delays are a source of annoyance and expense, which nobody will incur knowingly, therefore if it is decided to use a water-tube boiler in either new or an old plant, one should be selected that has proved satisfactory in other places, under like conditions. This is important and should be emphasized.

If samples of all water-tube boilers now made could be brought together, it would make a surprising array, and it is safe to say that one-half of them have not passed an experimental stage. Some of the new ones may be just as good as those which have proved their sterling value, but we do not know this yet, and inasmuch as experimenting with new and untried boilers often proves very expensive, it is a good plan to let somebody else do it.

When gathering evidence on which to base a decision concerning the adoption of any form of boiler, its capacity for holding water and steam should be considered under two heads as follows: First,—Is it desirable to have a boiler of large capacity? It is generally admitted that it is proper to pump water into a boiler at the same rate that it is evaporated, but it is not always desirable or convenient to do this, as the following illustration shows: When steam is put on the building that I am employed to care for, on a cold morning, it requires a large volume of steam during the first half-hour, and this lowers the water level rapidly, because much of the condensed steam has not come back from the radiators. Soon it begins to return, so that if there is three gauges of water in the boilers, they will soon be flooded, making it necessary to allow some of it to go into the sewer. On the other hand, if the water level stands at about 1½ gauges, there is room enough for all that comes back so that none of it is wasted, as these are tubular boilers, 66 inches in diameter, 27 inches from tubes to shell, making quite large storage capacity.

A portion of this excess may be due to water that has settled to the receiver during the night, as it is not a gravity return system. Now suppose that this plant was fitted with boilers having but small capacity for water. When the hot water pump is running fast during the period above mentioned, it would be necessary to allow much water to go into the sewer, and this means a waste of money.

If there is some advantage gained by using boilers that hold but little water, that overbalances this objection, it will of course pay to install them, but trouble is caused by the fact that all of these points are not taken into consideration in all cases.

The second head under which the capacity of boilers should be considered, is as follows: Does the boiler under consideration possess a large capacity for water and steam? A tubular boiler may not hold much water, because the lower half of shell is practically filled with tubes, leaving no place for a solid body of water, and these may be continued nearly up to the proposed water level. On the other hand a so-called water-tube boiler may have a large steam drum that must be carried more than one-half full of water, in addition to one or two mud drums, several headers, etc., so that it requires a large quantity of water to fill it. The intelligent investigator will allow none of these points to escape his notice.

If a sectional boiler is fitted with straight tubes and they become coated with scale, it is possible to clean them with a good tube cleaner, but what can be done with tubes that are about as crooked as ram's horns, when they become scaled?

It is useless to say that this will never happen for it will under some conditions, which are commonly found in practice. If the boiler that it is proposed to use, gives trouble in other places, and the conditions are the same, this point should receive careful attention before it is decided to invest money in such a boiler.

This is the only kind of evidence that is worth much in this case. If it is known in advance that the conditions under which a boiler is to be run, call for raising steam very rapidly, a water-tube boiler should be adopted, as this type is superior to all others in this respect, provided one is selected that holds but little water. Of course this pressure will fall as rapidly as it rose, if a steady fire is not maintained. I have raised steam at the rate of 4 pounds per minute in an ordinary tubular boiler, under common working conditions, but that is not quick enough for some places.

It seems to be the policy of some steam users, to hire men that work for the lowest wages, to care for their boilers, and even if they secure good men at reasonable prices, they hire others to take their places at lower wages, if it is possible to do so.

Every man who reads this article, knows what his policy is to be, if he hires engineers or firemen, and in case that he adopts the policy just mentioned, he should select a boiler that will do the least damage when it fails under pressure, and this should be the principal point considered, for it certainly will fail sooner or later, and another mysterious (?) boiler explosion will be reported, after which a coroner's jury will meet and declare that the owner is not responsible for the catastrophe.

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The Composition and Properties of Ammonia

By T. H. Reardon

Ammonia is an article that is used so extensively in the industrial arts, not to mention its usefulness in the household that a description of its production, composition and properties cannot fail to be of general interest.

Ammonia is formed by the chemical union of the gases hydrogen and nitrogen and has the chemical formula NH_3.

The molecule of ammonia consists of 1 atom of nitrogen united to 3 atoms of hydrogen, or by weight it consists of 14 parts of nitrogen and 3 parts of hydrogen.

Hydrogen and nitrogen, the constituents of ammonia, cannot be made to combine when brought together in the free state, in fact they show no tendency to combine, but when a compound that contains these two elements is subjected to the process of destructive distillation, such as takes place in a gas-works retort, at the instant that the two gases are liberated from other compounds being as it is termed in the nascent condition they combine at once to form ammonia.

The ammonia being extremely soluble in water is absorbed at once. The recovery of the ammonia may be effected in different ways; it may be expelled from the solution by heat, passed through quicklime to free it from water and to fix any acid that may be present, or the solution may be neutralized with hydrochloric acid and evaporated, when it will be recovered in the condition of ammonia-chloride or salammoniac, which readily yields anhydrous ammonia when heated with quicklime.

Anhydrous ammonia is in its natural state a powerfully alkaline compound gas, having a specific gravity of .590 compared with air, and requires for its liquifaction a temperature of 40° below zero at atmospheric pressure, although by the application of easily obtained pressures it may be liquified at any convenient temperature. The specific gravity of the liquid anhydrous ammonia at 40 is .6362 and at a temperature 103 degrees below zero it freezes or becomes solid. Aqua ammonia the form in which ammonia has its most extensive application is simply a solution of the gas in water, the water taking up various amounts of the gas according to the strength of the article desired.

The strongest aqua ammonia is the lightest, a solution containing 10 per cent. has a specific gravity of .9593, one containing 20 per cent. .9251, while a solution of 36 per cent. has a specific gravity of .8844.

The gas as previously stated is extremely soluble in water at a temperature of 32 degrees 1 volume of water absorbs 1149 volumes of ammonia gas.

Ammonia is always formed when organic matter containing hydrogen and nitrogen undergoes decomposition, as this is only a form of combustion that takes place slowly.

Ammonia has no corrosive action on iron or steel, but it is very injurious to brass, corroding it badly in a very short time, for this reason brass valves, etc., cannot be used in any part of an ammonia system where they will be exposed to the action of ammonia. The extreme solubility of ammonia in cold water, and its lack of solubility in hot water has a very ingenuous application in the absorption system of artificial refrigeration, after the anhydrous liquid ammonia has expanded under the effect of reduced pressure and assumed the gaseous condition, it is only necessary to bring it in contact with cool water in order that it shall be again absorbed.

After absorption has taken place it is only necessary to boil the ammoniacal solution to expel the gas, apply cooling effect and pressure and the ammonia is reduced to the liquid condition and is again ready to start out on its original cycle of expansion and vaporization.

The production of cold by the change that a liquid undergoes in passing from the liquid to the gaseous state is a sort of a paradox to a great many people. The idea of building a fire for the purpose of making things colder is a matter that does not readily explain itself in the matter of consistency to the man whose knowledge of natural processes is only superficial.

It is a well-known fact that to make a liquid boil and pass into the state of vapor, that it must receive heat from some source. It is equally obvious that if heat passes from one substance to another substance that the heat received by the one must be lost by the other, in other words, if a substance that is capable of absorbing heat, owing either to its temperature or condition is brought in contact with another substance it will become warm, while the substance that furnishes this heat to the last mentioned substance necessarily becomes cool, as the gain in the one case is dependent upon the loss in the other case.

The temperature at which different liquids boil and vaporize is dependent first on the physical properties of the liquid and furthermore it is influenced by the pressure to which the liquid is subject. Some liquids have very high boiling points, linseed oil, sulphuric acid and mercury if it may be included are representatives of such a class, the boiling point being approximately 600 above zero in these three instances. In the opposite extreme we find such substances as liquid carbon, dioxide, sulphurous oxide and liquid air, with boiling points anywhere from 100 to 300 below zero.

The particular property of ammonia that adapts it to the production of artificial cold is, that while its boiling point is sufficiently low for the production of any temperature required in practice, the pressure necessary for maintaining it in the liquid condition is not excessive and is easily within the range of practical limits, whereas, if such an agent as carbon dioxide were used, the confining apparatus should have sufficient strength to withstand a pressure of 800 pounds per square inch without any factor of safety.

Another point in favor of ammonia is that it has no action on iron and if leakage should occur in any part of the system, the escaping gas, while unpleasant to inhale, is neither poisonous nor inflammable.

The fact that such an inert element as nitrogen, constituting as it does four-fifths of the air we breathe, should in combining with hydrogen, also a harmless constituent of the water we drink produce such a pungent powerful substance as ammonia, is indeed only one of the many wonderful changes that take place in nature's laboratory. It may be interesting to state in connection with the foregoing that the constituents of ammonia with the addition of oxygen form nitric acid, and with only the addition of carbon, that swift and deadly poison, prussic acid is produced.

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Boiler-Room Chemistry

The study of chemistry is always interesting, and the experiments which it entails are fascinating in the extreme. To put together two small volumes of odorless, colorless gas, and to burn them, and to show as a result a little drop of crystal water, all has in it the hint of magic. There is little of magic in true chemistry, much as there appears to be. Every action and reaction has its reasons, and can be properly accounted for and explained.

Chemical actions are continually occuring about us, but the most of them are so gradual, so silent, that we do not notice them particularly. However, if there is any one place where the engineer can find evidences of chemical phenomena, it is in the boiler-room of his plant.

The first of these which suggests itself is combustion of the fuel in the furnace, and the process is known as a very rapid oxidation. That is, the carbon, hydrogen and sulphur of the coal unite with the oxygen of the air to produce carbon dioxide, water and sulphur dioxide.

It will be noted, too, that each of these substances or elements undergoes a change of state, and that the new compounds formed do not resemble the original elements. The carbon has changed from a solid to a gaseous state, the hydrogen has changed, with the oxygen, to water, in the form of steam, and the sulphur, originally a solid, is also changed to a colorless gas.

This is a peculiarity of chemical compounds. When two or more elements combine chemically, they form a compound which is different in its properties from any and all of the substances which enter into the combination. It must also be remembered that no matter what the nature of the action, the weight of the resulting products will be exactly the same as the sum of the weights of the original elements.

For instance, let us take up the chemistry of feedwater purification. Feedwater may contain one, or more than one, of the following agents: Sediment, scale-forming materials, or corrosives. If it contains sediment alone, it will require no treatment before being fed to the boiler. But the boiler, on the other hand, will need to be cleaned frequently, and blown down still more frequently.

If it contains salts which when precipitated will bake into a hard incrustation on the shell, then it will be necessary to do more than blow down. In this case we must add some substance which, while not being harmful or detrimental in itself, will at the same time prevent the formation of solid scale, or render the salts sludgy and incapable of incrusting the interior of the boiler. This is the office of what are commonly termed boiler compounds.

Let us suppose, for example, that a certain feedwater is

found to contain sulphate of lime in large proportions. Sulphate of lime is a very common salt in feedwaters and causes a troublesome scale. The remedy is to add carbonate of soda to the feedwater. Sulphate of lime is represented by $CaSO_4$ in chemical symbols. This means that one molecule of sulphate of lime is composed of one atom of lime or calcium (Cal), one atom of sulphur (S), and four atoms of oxygen (O). Carbonate of soda, expressed in similar form, is written Na_2CO_3, showing that in one molecule of carbonate are to be found two atoms of sodium (Na), one atom of carbon (C), and three atoms of oxygen (O). This follows the same law which designates a molecule of water, H_2O, as being composed of two atoms of hydrogen and one of oxygen.

Now, when the water containing sulphate of lime is treated with the carbonate of soda, chemical action takes place between the two salts, and this action is expressed by the following equation: $CaSO_4 + Na_2CO_3 — Na_2SO_4 + CaCO_3$. The reason for placing this in the form of an equation is that not a single atom is lost in any chemical action, as was stated previously, and hence we must have as many atoms after as before the action takes place. It will be seen, upon examination, that the number of atoms of each elementary substance on each side of the above equation is precisely the same.

In this action we have changed the molecule of sulphate of lime and the molecule of carbonate of soda into one molecule of sulphate of soda and one of carbonate of lime. The reason for this action is that the sulphur and oxygen have a much stronger attraction for the soda than for the lime or calcium. And hence the Na_2 went to the SO_4 forming sodium sulphate and the Ca went to the CO_3 forming carbonate of soda.

Our troublesome sulphate of lime has thus been changed to the carbonate of lime. In this condition it is in a sludgy form and has no tendency to form solid incrustation under the action of heat. It can therefore be blown out whenever desired The sodium sulphate produced is very readily soluble in water and hence goes at once into solution. When the water becomes too strongly impregnated with this salt, it can be blown out and fresh water added, either at one filling, or by periodic injections.

If the scale-forming substance had been magnesium sulphate, the same treatment would have been found effective. In place of the $CaSO_4$ in the above reaction, there would have been $MgSO_4$, and the resulting magnesium salt would have been $MgCo_3$, or carbonate of magnesia, which would have been disposed of in the same manner as the carbonate of lime.

Corrosion is a not uncommon form of boiler trouble, and this is nothing more nor less than a chemical action. The water contains some acid or acids which eat away the plates of the boiler. The proper way to treat feedwater for such corrosives as free acids is to neutralize the acids by the addition of alkali. For example, let us suppose that a boiler is subject to the action of sulphuric acid in the feedwater. This acid has a strong affinity for iron, and if allowed to act unhindered, would soon weaken the plates to a dangerous degree. The formula for sulphuric acid is H_2SO_4, and for iron the symbol is Fe. If the acid should then corrode the iron, the action would be $2Fe + H_2SO_4 — Fe_2SO_4 + 2H$. This means that in acting on the iron, sulphate of iron would be formed as the plate is eaten away, and hydrogen gas set free to escape into the water and steam.

To prevent this, some alkali must be added, and caustic potash, or KOH, is a cheap one to use. The chemical reaction which follows this mixture is $H_2SO_4 + 2KOH — K\ SO + 2H_2O$. That is, the two molecules of caustic potash act on the molecule of acid to form one molecule of potassium sulphate and two molecules of water. This sulphate is soluble in water and hence there are no visible remains of this action.

Other acids which may be present are hydrochloric acid and carbonic acid. The former may be treated in the same manner as the sulphuric acid. The latter, H_2CO_3, may be gotten rid of by heating the feedwater before admitting it to the boiler. This heating will break up the acid into H_2O and CO_2, the carbon dioxide passing away and leaving the water free from carbonic acid.

External corrosion also claims an important place in the chemistry of the boiler-room. It is generally caused by the collection of moisture and soot or cinders on the external parts of the boiler. This moisture, in connection with the sulphur fumes from the burning coal, may form sulphuric acid and so corrode the plates. The remedy is to keep the outside of the boiler clean and dry.

Rusting of iron is also a slow chemical action. If a piece of soft iron be placed in a forge and heated above a welding heat, it will soon burn and emit a shower of brilliant sparks. These are particles of iron oxide, and if collected and allowed to cool, will be found to greatly resemble rust. In reality they are bits of rust, for rust is also an oxide of iron. But rust is the result of a very slow oxidation, while the flame oxidizes the iron very rapidly.

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C. Watson, an *American Electrician,* describes a steam plant where cracks in the brickwork of the boiler setting appeared, but which were so small the manager refused the engineer's request that they be repaired. An expert friend of the manager joined his voice to the engineer's and finally made a wager with the manager that he was wasting coal by his refusal.

A test of one week was arranged and carefully carried out; the fuel was weighed, the temperature of the feedwater taken, and the record of delivered power recorded. The brickwork was, at the end of the week, pointed up and the second week devoted to the comparative test. All conditions were made the same as before—height of feedwater in boiler, damper and temperature. It was found that the power delivered was a little more, and, to the surprise of the manager, the fuel was less by three tons ($10) the second week. Here was a saving of $500 a year effected by the expenditure of perhaps five dollars.

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That the adoption of the mechanical stoker on locomotives, particularly those of heavy power, is gaining in favor with railway officials is made plain by the increased activity of late in the manufacturing department of the Day-Kincaid Stoker Co., of Cincinnati, O., the firm that controls the patents of the Kincaid Locomotive Stoker. The company has made quite a number of tests during the past few months at the solicitation of interested railway potentates, and the results have been so satisfactory, the claims of the makers so completely verified, that it is said a number of the leading railways are contemplating equipping their engines with the stoker at an early date. In these tests it seems to have been clearly demonstrated that the new device makes great saving in fuel, lessens the labor of firemen and enables them to easily keep up plenty of steam, even on the largest locomotives. Other advantages claimed for it are an abatement of the smoke and spark nuisance and a saving of repairs in the fire box.

Water-Tube Boilers

We are often asked how to calculate the force which tends to draw a tube, in a water-tube boiler, out of the header or tube sheet to which it is secured ; and this article is intended as a general reply to the question. The problem is in reality extremely simple, and there should be no difficulty about it whatever, when the principle which underlies it is once correctly understood. Nearly every problem appears simple or difficult, according to the point of view from which we regard it ; and the main thing to do in the present case is to discover that particular point of view from which it will appear simplest of all.

The stress on the tubes of water-tube boilers is influenced (and sometimes very largely influenced) by the design of the boiler, as we shall show in the course of this article ; and in order to exclude all considerations except those of the most fundamental and elementary character, we shall first simplify the problem till it takes the following form : A pair of hollow boxes, made of cast iron or other rigid material, are joined by a tube. The whole apparatus is then filled with water and a known hydrostatic pressure is applied. The problem is, to calculate the force which is acting upon the tube under these circumstances, tending to pull it out of the boxes.

Let us first take the case where a solid, round shaft of iron, of the same diameter as the contemplated boiler tube, is run completely through both sides of both boxes. Under these circumstances it is plain that there can be no pull lengthwise on the iron shaft, because the pressures on the boxes are balanced in all directions. If the shaft were cut in two at the middle, neither part would move either to the right or to the left.

We have spoken of the shaft as being solid ; but obviously it can make no difference whether it is solid or not, provided it is everywhere closed, so that the pressure in the boxes cannot find its way into the interior of the tube. Let us therefore think of it, not as a solid shaft, but as a boiler tube, capped at the ends, and with no opening in it anywhere ; and let us remember that when such a tube is arranged as in this case, there will be no lengthwise stress upon it at all.

Let us now make openings into this tube at each end, so as to admit the hydrostatic pressure in the boxes to the interior of the tube. The pressure upon the sides and ends of the *boxes* will not throw any stress on the tube in this case any more than it did in the previous one ; but it must be noted that this differs from the former in the one important particular that the pressure now acts not only upon the boxes, but upon the ends of the *tubes* as well ; and hence, in the arrangement of the latter, there *will* be a lengthwise stress on the tube, and its amount will be just equal to the pressure exerted by the water against the end of the tube.

Let us now cut the tube entirely away. By so doing we shall not alter the lengthwise stress (or pull) on the tube, except that by cutting the tube we have exposed a small additional area to the action of the pressure, since the pressure now acts against the cut end of the tube, as well as upon the cap at the end. This difference is small, with boiler tubes of the usual diameter and thickness, and it is taken into account perfectly by basing our calculation on the external diameter of the tube instead of the internal one. Otherwise, as we have said, the lengthwise stress on the tube has not been changed by cutting it in two. The most important difference between making openings and cuttings in the two, is, that in the first instance there is no necessary stress between the tube and the boxes—that is, there is no tendency to blow the tube out of the boxes—and we do not need to provide for any "holding power" between the tubes and the boxes, since the stress on the tube is less at the ends of the tube, and the pull is transmitted from one end of the tube to the other, without leaving the tube at all. In the second case, however, this can no longer be true, because we have cut the tube, and the only way in which the stress can be transmitted from one end of the tube to the other is by means of the boxes.

It is necessary, therefore, in this case, to roll the tube in wherever it touches a box ; or else to provide an equivalent holding power in some other way. The force that the water exerts against the end of the tube on the left end is transmitted to the box, and through the box to the long section of the tube in the middle. It is then transmitted to the right-hand box, and through this box to the tube end, where it is balanced by the equal and opposite water pressure against this right-hand tube end. The total pull on the tubes is plainly equal to the pressure that the water exerts against a circle whose diameter is equal to the external diameter of the tube.

The tube ends may now be entirely dispensed with without effecting the problem at all ; for, as they stand in that view, they serve merely to receive the water pressure and transmit it to the boxes. We may therefore consider them to be, for all practical purposes, a part of the boxes ; and, as has been said, we may dispense with them altogether and merely consider the pressure of the water against a region of the box of corresponding size. The final outcome of our argument is, that the only force which tends to strip the box from the tube consists in the pressure of the water against the circle which is opposite the end of the tube, and whose diameter is equal to the external diameter of the tube.

This conclusion might have been reached much more simply by merely imagining the tube to be *rolled* into one of the boxes, and fitted to the other one by a stuffing box. It would be evident in this case, that the only force tending to separate the tube from the left end box would be the pressure against the end of the tube, and against the column of water within the tube—that is, it would be equal to the pressure exerted by the water against a circle of the same diameter as the outside of the pipe, just as we concluded in the preceding paragraph. The only objection to this simpler line of reasoning is, that it does not tell quite all of the story. It does not make it clear, for example, that the pull that the tube exerts upon the box is balanced by an equal and opposite water pressure against the opposite side of the box. For this reason we think the line of reasoning adopted above is preferable.

Let us take a numerical example. Let us suppose that the tube is 4 inches in diameter, externally, and that the pressure to be carried is 125 pounds per square inch, and that we wish to know the force which is acting between the tube and one of the boxes, tending to pull the tube out. We have seen that this force is numerically equal to the pressure sustained by a circle whose diameter is equal to the external diameter of the tube. In other words, we merely have to find the total pressure against a 4-inch circle. The area of a 4-inch circle is 12.57 sq. in. ; and the pressure against each square inch being 125 pounds, the total pressure against the 4-inch circle would be $12.57 \times 125 = 1,571$ pounds. The force tending to draw the tube from the box, in the case in question, is therefore 1,571 pounds.

Now President J. M. Allen, in his experiments on the holding power of tubes, found that the tubes of smaller diameter than this, when set in thinner plates than those customarily used in water tube boilers, and only expanded (without being flared or headed), did not begin to draw out until the pull was from 5,000 to 7,000 pounds. Even at these figures, the tube in our example would have a factor of safety of from 3.1 to 4.4. Making allowance for the greater thickness of the usual headers or tube sheets of water-tube boilers, it is probable that in most cases the factor of safety, so far as the pulling out of expanded tube is concerned, is from 5 to 7.

In order that there may be no misunderstanding in this matter, we desire to qualify this conclusion in certain ways. In the first place we have assumed throughout that there is no stress thrown on the tube except that which is due to the pressure of the steam. The condition, which is all-important, is probably very nearly fulfilled for the long tubes which in most styles of water-tube boiler, furnish the greater part of the heating surface. It is *not* usually fulfilled, however, for the *nipples* which are often used for connecting the different parts or units of the boiler with one another. A second condition for the applicability of the general conclusion given above is, that the material and workmanship must be of the best. The tubes must be of proper thickness, and the rolling must be done carefully and well. These are especially important points, as, if they are neglected, the holding power of the tubes will certainly fall below that assumed in our calculations, and hence it will be impossible to realize a proper factor of safety.

Another condition to be observed is, that the design and construction of the boiler must be such that the stresses are properly distributed, so that each tube may carry only its own fair share of the load. Consider, for example, the arrangement of things where we have a bank of tubes opening into a box or drum, which is originally flat. The pressure acts against the right end of the drum, and the head of the drum will tend to bulge out. The pressure against the head of the drum produces a tension in the cylindrical part of the drum. Now, if the tube sheet is not exceedingly rigid, it will yield somewhat to a severe pull like this, and it will tend to bulge outward. The result will be that the joints between the tubes and the tube sheet will be severely strained, and the tubes may even pull out at these points and give rise to a disastrous explosion. Trouble of this kind is especially to be looked for when there is any overheating of the tube ends, and consequent lessening of their holding power.

The load carried by the outer end of the box or drum may be transmitted more equally to the tube sheet by the use of a sufficient number of properly distributed stay-bolts.

It appears fitting that we should close this article with the following sentence, which occurs also in the final paragraph of our leading article for last July, "To prevent misapprehension on the part of any reader who may fancy that this article deals with some one particular sectional boiler, we desire to state that the text of this article is not intended to refer to any one make of boiler.—*The Locomotive.*

A school teacher the other day asked her pupils to write a long sentence, and one of the boys nearly caused her to faint when he wrote "Imprisonment for life."

"The Retarder."

A Practical and Simple Economizer.

The retarder, or more properly speaking, the radiator, is an article which will well repay the engineer to study. This device, while it is simple in the extreme, under certain conditions obtains an economy in steam-boiler practice which is surprising.

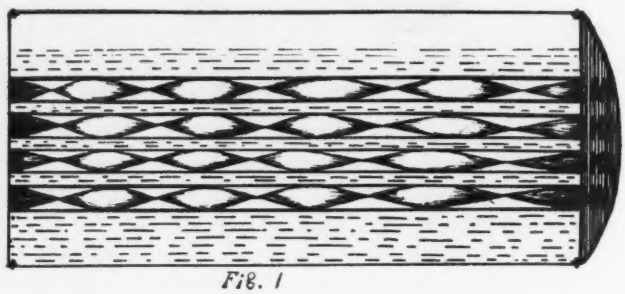

Fig. 1

A retarder is a thin strip of sheet iron fitting loosely in and running the whole length of a tube. This iron is twisted one or more spiral convolutions in its whole length. (See Fig. 1.)

For some reason or other the retarder is used but little in this country. The selection of the name "Retarder" is not a happy one, though, of course, it does obstruct or retard the flow of gas through a tube, as any obstruction in a tube will retard the flow of the gasses through it; but the object of a retarder is a wholly different one, and really has nothing to do with the flow of the gasses in the retarding sense.

Retarders are intended to increase the amount of heat transmitted to the tube surface from the hot gasses, and it does it in two ways: First, by a mixing action upon the gas in the tubes. The friction upon the surface of the retarder aid in stirring up the gas in its passage through the tube, and in mixing the hot gas at the centre with the cool film next the surface of the tube; also in every horizontal tube there is a tendency for the gases to be cooler in the upper part of the tube and hotter in the lower, for the upper part extracts heat far more readily from the gases than the lower half. The twist of the retarder has the effect of repeatedly turning over the gas in the tube as it flows along.

In the second place, the retarder acts by direct radiation of heat to the tube surface. While this action may not be apparent at first sight, it is of such importance that it should be clearly understood. To this end the fact should first be realized that the temperature of the tube surface exposed to the fire in any steam-boiler is practically the same as that of the water in contact with it, no matter what the temperature of the gas on the other side, supposing, of course, that the tube be clean. The reason is that the water absorbs heat many times as rapidly as gas. Now, suppose we place in the tube any solid body, of any shape whatsoever. Manifestly, as it is surrounded and bathed on all sides by gases at a temperature of, say, 1000° Fahr., it will if it loses no heat, soon become the same temperature of the gases. Suppose the surface of the tube is of a temperature of 300° Fahr., the hot body at the centre of the tube will radiate heat energetically to the walls of the tube, and will materially increase the amount of heat transmitted to the water.

A trial of this method of retarding the gas-flow through the tubes was made by J. M. Whitman to ascertain under what conditions, if any, they would add to the efficiency of the boiler. The boiler was 60 inches diameter and 20 feet long,

fitted with 44 tubes 4 inches in diameter. The water-heating surface was 1137 square feet. Ratio of heating surface to grate surface was 42.6 to 1.

The conclusions reached were:

Retarders in fire tubes of a boiler interpose a resistance varying with the rate of combustion.

Retarders result in reducing the temperature of the waste gasses and increasing the effectiveness of the heating surface of the tubes.

Retarders show an economic advantage when the boiler is pushed, varying in the tests from 3 to 18 per cent.

Retarders should not be used when boilers are used very gently and when the stack draught is small.

It is probable that retarders can be used with advantage in plants using a fan or steam-blast under the fire, or a strong natural or induced chimney draught, when burning either anthracite or bituminous coals retarders may often prove to be, for an existing plant, as economical as most any economizer, and will not in general, interpose as much resistance to the draught.

The economic results obtained on the boiler tested are ideal, showing that it was clean, the coal good in quality, and the firing skilful.

With retarders, the tubes are more effectively cleaned than without their use.

While the above mentioned tests were, of course, carried on under the most advantageous circumstances, yet the showing made is no more creditable than that which can be obtained upon any like boiler where the draught is good and strong and other ordinary conditions prevail.

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Chimneys

From "Boilers and Furnaces," by Wm. M. Barr.

A chimney is employed in steam engineering as an attachment to a steam-boiler furnace for the purpose of creating and maintaining a draught through the body of burning fuel. Its practical value as compared with other methods is in the certainty and simplicity of its action, adapting itself automatically to the demands of a lesser or greater number of furnaces, with little or no loss of efficiency for either under or over-load as compared with its normal power-rating.

The fuels used for steaming purposes in this country are anthracite, semi-anthracite and bituminous coals. The first of these is a very hard coal, and requires a powerful draught for its rapid combustion. Bituminous coals are found in every grade of quality from good to bad; they burn readily, and thus a less intensity of draught is needed. It is for this reason that a less height of chimney is permissible.

The rate of combustion per square foot of grate surface per hour will ordinarily vary from 9 to 13 pounds for anthracite coal, and from 12 to 20 pounds for bituminous coal—the latter occasionally running much higher, nearly or quite doubling these figures. We shall not go far wrong if we assume an average rate of combustion of 12 pounds per hour for anthracite coal and 15 pounds per hour for bituminous coal in ordinary steam-boiler furnaces with good draught. The evaporative economy falls off rapidly under the higher rates of combustion of bituminous coal.

The temperature of air supplied boiler furnaces may vary in certain localities from 10° below zero in winter to 95° Fahr. in summer. Assuming 62° Fahr. to be an average temperature, the corresponding weight of the air will be 0.076 pounds per cubic foot, or 13.14 cubic feet to the pound at atmospheric pressure (14.7 pounds); in relation to water its density is about 1 to 820. If the combustion were perfect, with the minimum supply of air (12 pounds) the weight of the products of combustion would be 13 pounds, but for chimney calculations it is customary to assume the maximum of air supply, or 25 pounds of gas.

Chimney draught is an effect produced by the difference in specific gravity of the cold air entering the furnace under the grate and the heating products of combustion escaping from the chimney. The difference in weight is explained by the fact that gases expand by heat; the atmosphere of an active fire must be of less density than the outer air.

The draught of a chimney depends upon its height, and the difference between the specific gravity of the gases with which it is filled and that of the outside air. Draught properly begins at the level where the air passes through the fire, and not at the level of the ground at the base of the chimney. Its action increases at first with the temperature, but afterwards diminishes with the temperature of the gasses. For example, from 32° Fahr. to 300° Fahr. the draught augments very rapidly; from 300° Fahr. to 750° Fahr. the draught varies little, but arrives at the maximum when the temperature is about 585° Fahr. Some investigators place the temperature higher than this, but for steam boiler purposes this temperature is as high as the products of combustion should be allowed to attain, and from 550° to 600° Fahr. may be taken as the maximum temperature in any ordinary calculations. Some steam-boilers do not part with their gases until the temperature is reduced to 450° Fahr. and only occasionally is the reported temperature less.

Intensity of draught denotes the velocity of flow of air through the furnace. This property is secured by height of chimney, or by high temperatures of escaping gases, or both. The larger of the small sizes of anthracite coal require an intensity of draught corresponding to not less than seven-eighths to one inch of water, and even this is scarcely enough at times to secure the desired rate of combustion; whereas with ordinary free-burning coals in lumps as large as a hickory-nut, or larger, a draught of three-eights to five-eights inch of water will suffice for ordinary boiler settings

Chimney draught from absolute zero.—The best practice when dealing with problems relating to heated gases is to reckon temperatures from absolute zero (which on the Fahrenheit scale is 460°), because the expansion of a gas due to a given rise of temperature is found to be exactly proportional to the absolute temperature.

The best chimney draught is had (reckoning temperature from absolute zero) when the temperature of gas in the chimney is to that of external air as 1 is to 3. The absolute temperature of air at 62° Fahr. is 62+460=522; therefore we get the best draught when 522x2=1044° absolute, or 1044°–460°=584° Fahr., a temperature above the melting-point of bismuth (518° Fahr.) and below that of lead (630° Fahr.) In general, when the escaping gases leave the boiler at a temperature of melting lead, it indicates that heat is going to waste.

Example: Suppose a chimney 120 feet high, the temperature of escaping gases=584° Fahr. and that of the atmos-

phere 62° Fahr., the draught in inches of water may be found thus:

$$120 \times \frac{460+584}{460+62} = \frac{125,280}{522} = 240 \text{ feet.}$$

The height of a column of escaping gas at 584° Fahr. equals the weight of a column of air at 62° Fahr. outside a chimney 120 feet high; then 240–120=120. We will call this remainder the "motive column."

The relation of weight as compared with water (820 times heavier) may be expressed thus:

$$\frac{820 \times 240}{120} = 1640.$$

If we divide the motive column by this amount we have

$$\frac{120}{1640} = .0732 \text{ Foot.}$$

or 7/8 inch nearly, as the height of a column of water lifted by the action of a chimney correspondingly to the height and temperature here given.

Temperature:—If we assume that air entering the ash-pit is increased in temperature from 62° Fahr. to 2500° Fahr. in its passage through the bed of burning fuel, its volume will have been increased 5.663 times; that is, the volume occupied by 1 pound of air at 62° Fahr. is 13.14 cubic feet and would be expanded to 74.40 cubic feet at the increased temperature; or, the weight of 1 cubic foot would be less in the proportion of 0.0761 to 0.0134 pounds. This sudden expansion, occurring as it does within a distance of 6 inches or thereabouts, and probably in less than a half-second of time, means the acceleration of its velocity, due to increase in volume alone, from 1 foot below the grates to more than 5½ feet per second at the surface of the fire.

This sudden rise in temperature does not immediately affect the draught, for it is confined to the furnace alone, and this is always partially, and sometimes wholly surrounded by absorbing furnaces, so that after the passage of the heated gases along the absorbing surfaces, the temperature of the escaping products of combustion is lowered from the original temperature to about ¼, or less, at the moment of entering the chimney. It is this final temperature only which is to be taken into account in draught calculations. This continual loss of heat by coming in contact with absorbing surfaces has the effect to retard the flow of gases from the furnaces to the chimney, but another and more serious retardation of flow of air into the furnace occurs in the passage of air through the fire itself, and this is greatly intensified in the case of fine anthracite coals or of caking bituminous coals, the former often requiring a strong and positive blast to force the air through the fuel. With the latter fuel a frequent breaking up of the fire becomes almost a necessity to maintain a proper rate of combustion. For natural draught the temperature of the escaping gases should not generally exceed 550° Fahr.; all things considered, this is regarded as a fair and economical working temperature. Variations above and below this temperature, say 50° Fahr., have but little effect on the draught so far as the economical result of furnace working is concerned.

An approximate method of determining high temperatures consists in suspending strips of metal, the melting-points of which are known, in the flues leading to the chimney, or perhaps in the chimney itself. Three different metals, such as tin, which melts at 455° Fahr., bismuth, which melts at 518° Fahr., and lead which melts at 630° Fahr., to which may be added zinc, which melts at 793° Fahr., and antimony, which melts at 810° Fahr., are generally employed in making such tests. In the selection of metals one is chosen of which the melting-point is nearest the supposed temperature, then another piece the melting point of which is below, and a third of which the melting-point is above it. For example, if the temperature be supposed to be about 600° Fahr., then lead will be chosen for the central strip, and one of bismuth for the lower, and one of zinc for the higher temperature. The temperature can readily be approximated when it is known that it is between two of the three metals exposed. If the metal having the lowest melting-point is melted and the other two are uninjured by the heat, the temperature must be assumed to be above the one and below the other; similarly, if two of the bars are melted, the temperature must then be somewhere between the highest and the intermediate points of fusion. This method is not entirely accurate, but sufficiently so for all ordinary purposes.

The area of a chimney was made the subject of experimental research by Mr. Isherwood, who found that the ordinary variable limits were from one-sixth to one-ninth that of the grate area. Upon these experiments it bases the common recommendation that the area of a chimney be one-eighth that of the grate surface.

The grate area for a steam-boiler bears an approximately fixed relation to that of the heating surface, averaging not far from one-thirty-fifth that of the latter.

The chimney area must bear some relation to the quantity of coal burnt. In practice it is found that for sizes up to 1000 horse-power, the most satisfactory chimneys are those in which from ½ to 2 square inches of chimney area are had for each pound of coal burnt per hour. According to this rule, a chimney suitable for 1000 pounds of coal per hour would vary between 1000x1.5=1500 square inches, or 43¾ inches diameter, and 1000x2=2000 square inches, or 50½ inches diameter.

Example: Required a grate and chimney area suitable for 1000 pounds of coal per hour, the rate of combustion to be 12 pounds per square foot of grate per hour:

$$\frac{1000}{12} = 83\ 3 \text{ grate area in square feet.}$$

$\frac{83.3}{8}$=10.4 square feet=1498 square inches=43¾ inches, diameter of chimney, which corresponds to 1½ square inches of chimney area for each pound of coal burnt per hour. It also corresponds to one-eighth that of the grate area.

Heighth of chimneys:—In order to give the required draught to a steam-boiler furnace of say 50 horse-power, the chimney should not be less than 60 or 65 feet in height above the ground surface at its base, and need not exceed 150 feet for boiler furnaces of 1000 horse-power, unless there is higher land or buildings in the immediate neighborhood which would affect its draught. Anthracite coal requires a higher chimney than free-burning bituminous coals. The area having been fixed, either by quantity of coal burned or in proportion to grate area, a common rule is to make the height of a small chimney twenty-five times its diameter, with a gradual decrease in the ratio for larger chimneys; thus, a 4-foot chimney may be 100 feet in height, a 5-foot chimney 120 feet in height, a 6-foot chimney 135 feet in height, an 8-foot chimney 160 feet and a 10-foot chimney 175 feet.

The formulas usually given for the height of chimneys do not always furnish the proportions which certain localities seem to require, and as a result there is more of empircism than calculation in this detail. Many large chimneys are higher than necessary when considered merely as a means of obtaining or maintaining a good draught. It is doubtful if there are any advantages sufficient to pay the extra cost for making a steam-boiler chimney more than 150 feet high for internal diameters less than 100 inches.

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A New and Unique Use for Compressed Air

One of the most remarkable developments in the recent history of engineering progress is the constantly increasing use of compressed air as a medium for performing various industrial operations.

Pneumatic tools and other appliances for the utilization of compressed air have been introduced into one field after another, with successful and gratifying results, so much so that the advantages of compressed air for a wide variety of purposes, are now fully recognized.

One of the most unique and withal effective uses to which this power is now being put, is that of welding the steel rails used on our street railways. This is a project which at first thought would seem an impossibility, but with the advent of the electrically driven air compressor the work can be accomplished with ease.

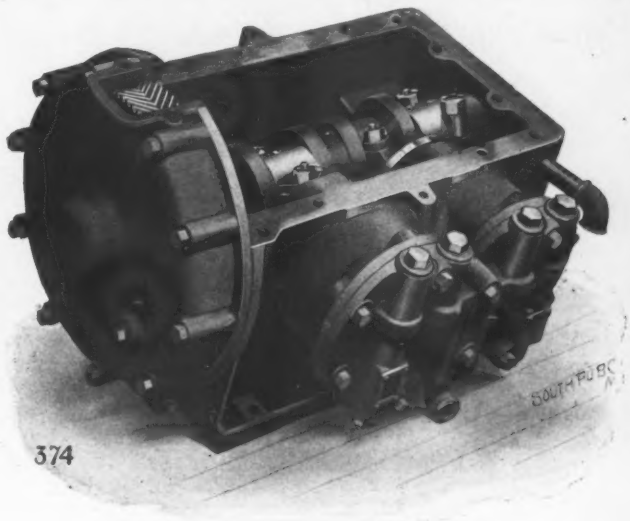
The accompanying illustrations show the style of motor

COMPRESSOR, WITH COVER REMOVED

driven compressors in use for the purpose. The manufacturers are the Christensen Engineering Company, Milwaukee, Wis. The method of operation is conducted in the most simple yet interesting manner.

The trucks carrying the electric compressors and tanks are arranged to run either on the trolley tracks or on the roadway; a wire is connected to the trolley feed wire, at any point desirable; by this means a constant supply of air can be maintained in the compressor by the motors.

At the points where the rails meet a sort of half cylindrical shell partly encircles the tracks from above. This shell is itself a complete gasoline burner; the gasoline is driven by means of the compressed air through a coil pipe from which it emerges through a number of holes in the burner in the form



COMPRESSOR, WITH MOTOR REMOVED

of gas, this gas is directed immediately upon the point desired to be heated. Meanwhile a composition of metals has been heated to a molten condition in a crucible and when the track ends have attained the proper heat a mold is screwed upon it into which the metal is poured. The rails being heated to the same degree as the composition metal they instantly fuse into each other, thus forming practically a solid rail, this is continued from joint to joint until the tracks are practically a solid line, doing away entirely with the evils of the fish plates, which has heretofore been productive of so much trouble through becoming loose from contraction and expansion. The welding of tracks is only one of the many uses this style of machine can be put to. In cases where piping cannot be used to an advantage as a conduit for air, a wire can be run from any electric feed service wire to the portable compressor. In this way the compressor can be taken to the work, no matter what it may be, instead of transmitting the air from a distance.

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Oldest Engine in Use

Probably the oldest steam engine now in use is one employed for hauling up coal out of a mine at Rutherglen, Scotland, which has been at work since 1809, says *Popular Science News*. This engine is a curiosity, as it is the last survivor of the old Newcomen type of engines, now long since superseded. The cylinder is 3 feet in diameter and 6 feet high. The flywheel is 15 feet in diameter. Like all the early engines, it is a condenser. The valves are worked by hand instead of automatically. A boy turns a cock and lets in steam, and the piston slowly rises, and when the end of the stroke is reached he shuts off the steam and opens another cock, which admits cold water to the cylinder. This condenses the steam and forms a partial vacuum, which causes the piston to descend.

The Practical Engineer.

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By L. L. RICE, 1213-15 Filbert Street, Philadelphia, Pa.

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Municipal Council, P. F. D., No. 2-, of Philadelphia, has moved to new quarters in Odd Fellows' Hall, Third and Brown Streets, where they will hold regular meetings the second Thursday of each month instead of quarterly, as formerly. This Council is composed exclusively of engineers of the Paid Fire Department of Philadelphia. They are a thoroughly first-class lot of "fellows" and will make all visiting brothers welcome.

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This issue contains an interesting letter from Supreme Chief Williams offering advice of the proper sort. This letter will be followed by others, all of which members of the A. O. S. E. will do well to read carefully.

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Delaware County Council, No. 6

Editor PRACTICAL ENGINEER:

Delaware Council, No. 6, of Chester, Pa., entertained her engineering friends in a royal manner at Carpenter's Hall, Saturday evening, June 14th. Besides the local engineers, there were delegations present from Delaware Council, No. 1, of Wilmington, Del., and Kensington Council, No. 3, of Philadelphia.

The evening was spent listening to addresses by the visiting members, and to educational work on the black-board, after which the guests needed and received something (shall I say better?) in the way of cake, lemonade and cigars. During the evening quite a dispute arose between a Wilmington engineer and a visiting member from Kensington Council as to which did the smallest amount of work. If left to a vote it would be hard to tell which side would win, but if all the engineers had as soft a snap as those two men claimed to have the only wonder would be that men could be found to work at anything else.

After receiving quite a number of applications for membership, the meeting adjourned to the street railroad power house, where the plant was put through a critical examination until train time, when we left, regretting that an evening cannot be lengthened out an extent equal to that of the pleasure crowded into it. Respectfully,

A. EDWARD RHODES.

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The New Deputy Supreme Chief of Maryland

A. J. Deidrich, of Baltimore, has been appointed Deputy Supreme Chief for the State of Maryland, to succeed James H. Stallings, recently elected Supreme Recording Engineer. Mr. Deidrich is a deserving and popular young engineer. He has been a member of the Order for several years and has always been one of the foremost workers in his State, is chief engineer of the big Continental Trust Building, and is known from one end of the city to the other. Supreme Chief Williams appointed him deputy upon the joint recommendation of Maryland and Energy Councils, of Baltimore.

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A 20th Century Council of the A. O. S. E.

The progressive spirit which is being displayed by Kensington Council No. 3, A. O. S. E., is well worthy the emulation of others. Following the time worn maxim, "nothing succeeds like success" Kensington Council on Thursday night, June 19th, started out with the laudable object in view of showing the engineers of their section of Philadelphia just how much they are missing in failing to be members of their council. How well they succeeded can be judged from the unprecedented number of applications presented for membership during the evening. The success of the method employed by Kensington Council to disprove any reference which might have been made as to its being decreased, was evidenced by an attendance of more than two hundred engineers of that district.

The affair was a, "free for all engineers," meeting in the well apportioned lodge rooms of the council.

The features of the evening was an exceptionally well rendered talk, upon the merits of the American Order of Steam Engineers by Past Supreme Chief Engineer James Lightfoot, followed with a lecture delivered by that popular engineer Charles Cook of Kensington Council, upon the Indicator. Mr. Cook's ability in that line was well evidenced by the attention given him throughout his discourse and by the noisy and unanimous demand for an encore made by his listeners.

Following Mr. Cook, Mr. Fred W. Moore, Chairman of the evening's entertainment committee, made a short address in which he most cordially invited those present to a substantial

appreciation of the large attendance, which was in readiness on the floor below.

The zeal with which this part of the entertainment was attacked attested to its successful preparation and its popularity, and it can be truthfully said that there are some members of Kensington Council who don't belong to the "Blue Ribbon Society." The epicurean tastes of those present were also well supplied from a table groaning with seasonable delicacies.

While the evening's entertainment progressed the members of the Council were unfailing in their efforts to place everyone at ease. The only expressions of regret or dissatisfaction displayed by the strangers present was that they had not sooner become acquainted with Kensington Council, A. O. S. E., and its benefits both socially and intellectually. Needless to say application blanks were in great demand, and the appeal for the loan of a pencil made from every side would indicate that Kensington Council will continue to lead the procession in Philadelphia if some of the others don't display more energy.

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Manayunk Council

At the regular stated meeting of Manayunk Council, No. 9, the following resolutions were unanimously adopted:

Whereas, It has pleased Almighty God to remove from our midst the wife and companion of Brother William Beaderker,

Resolved, That Manayunk Council, No. 9, American Order of Steam Engineers, extend their sincere sympathy to the bereaved husband and family of his loss; be it further

Resolved, That a copy of these resolutions be sent to Bro. William Beaderker and entered on the minutes, and published in the official journal of the A. O. of S. E.

Committee { GEORGE W. RICHARDSON, RICHARD WALLACE, WILLIAM BEATTY.

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Sunbury Council, No. 19

SUNBURY, Pa., June 14, 1902.

Be it resolved that,

Whereas it has pleased the Supreme Engineer of the Universe, in his infinite wisdom, to remove from the sphere of his earthly usefulness the beloved wife of our Brother, Cameron G. Young. And while we bow in humble submission to the Divine will, it is hereby

Resolved, That we express our heartfelt sympathy with our Brother in his bereavement; and be it further

Resolved, That a copy of these resolutions be placed on the minutes of the Council, and also that a copy be printed in THE PRACTICAL ENGINEER and a copy be printed on a card and delivered to our bereaved Brother.

Committee { R. D. MANTZ, ED. SCHREIBER, S. E. LEES.

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Oil or tar is used as an auxiliary to coal on express locomotives for the Eastern Railway of France. Each injector allows the burning of 220 pounds of tar per hour under good conditions. The tar receiver holds one ton.

Work for You

Philadelphia, June 17th, 1902.

To the Individual Member of the American Order of Steam Engineers:

Dear Sirs and Brothers—In assuming the duties of the office of Supreme Chief Engineer for the third term I take this means of requesting the energetic co-operation, assistance and support of each individual member of our Order, to the end that the work of promoting its growth may progress with greater strides during the current year than it has in any of the years that has preceeded it, so that the influence and power of a concrete organization of engineers, for engineers and engineers only may be extended into every city and state of this Republic, as by so doing we will secure to the American Order of Steam Engineers a larger sphere of usefulness and thereby make it a more powerful factor for the improvement of the conditions which surround us in our chosen vocation, and consequently procure for our calling that recognition which every steam engineer should enjoy as the result of the importance of the power which he manipulates. It is an unquestioned and undeniable fact that the power of steam has become to-day almost as indispensable as the very elements from which it is created. Why, therefore, should we not put forth our best energies in working for the upbuilding of the American Order of Steam Engineers, if by so doing we acquire for ourselves, both as individuals, and as a collective body, that just recognition and treatment to which all steam engineers are entitled, by virtue of the importance of the value of their calling to their employers and to their fellow men?

The question naturally arises, how can this greatly desired result be attained? I would answer by saying, that it can only be secured by leading each individual member of the organization to a realization that it is his personal duty to contribute his labor toward the success of the collective body, regardless of the work done or left undone by his brother members, and it is the purpose of this letter to awaken every member of our Order to the advisability and necessity of doing everything in his power to promote its growth, and not to leave the burden by the wayside, to be picked up and carried along by a brother member who is more energetic and enthusiastic in the work of the order, and who regards its welfare as a matter of individual concern.

"I will not leave it for others to do, I will do it myself." Let this be your slogan, and I promise you that you will have an unquestioned assurance that the organization will be the benefit to you that you expected it would be, when you assumed the obligation which unites us together for mutual advancement and improvement.

You do practically nothing for your personal benefit, or for the mutual benefit of the whole, if instead of attending the meetings of your council and taking a part in the work, thereby inducing others to follow your example, you stop in some working brother's engine room and persuade him to take your dues to the council so that you will be in good standing and thus be entitled to receive sick benefits.

If you have joined the organization only for its sick and death benefits, would it not be to your advantage to attend the meetings of your council? Would it not benefit you to induce the engineer who runs next door to join the council? Would it not be to your advantage to see that the business of the council is conducted in a business-like manner? Would it not be to your advantage to do your share of the committee

work and become better acquainted with the members? (Such acquaintances come in handy when you are out of a job), and are you so wise that it would not benefit you to take a part in the educational work?

You may not learn anything yourself but you may help someone out of a hole, you lose nothing by doing so, besides you may impart your knowledge to others and not lose it; you can give knowledge away but no one can take it away from you.

But gentlemen, I do not believe that you joined the American Order of Steam Engineers for the sick and death benefits only, but am persuaded that you desire to benefit others as well as yourself; in fact, you believe and I believe in the brotherhood of man, or otherwise we would not be associated together in this work.

You may not realize it, and I ask your pardon if this appears to you to be egotistical or conceited on my part to say to you that it was because I labored along the lines herein indicated, that your Supreme Council conferred the honor of Supreme Chief Engineer upon me for the third time; and it is because I believe it to be my duty to do so, that I have so labored. The same is true of my predecessors in the office and also of my colleagues in the Supreme Council; in fact, this is true of every energetic worker in the Order who has stepped out of the shadows, and appeared prominently before you as a member who has the best interests of our Order at heart. Still, there is work in the vineyard to be done, and there is a place, and a "work for you."

CLIFFORD P. WILLIAMS,
Supreme Chief Engineer.

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LETTERS FROM ENGINEERS

In order to make this department of THE PRACTICAL ENGINEER as interesting as possible, a moderate rate will be paid by us for all contributions published under this heading. However, we do not assume responsibility for the ideas or opinions expressed. None need hesitate to contribute because of inability to draw or write well. We will redraw or revise whenever necessary—it is the idea we want. New ways of doing old things, criticisms of accepted theories and general engine room experiences are especially solicited.

Steam Cylinder Lubrication

Editor PRACTICAL ENGINEER:

There is probably no subject so little understood by the average engineer as the proper lubrication of his steam cylinder. Take the steam engineering text books that are noted for giving the steam engineer much valuable information, and not one of them gives the reader any information on this valuable subject. Yet this subject belongs wholly to the subject of steam engineering and should come under the head of such studies. I think it nothing but right if the writers of such text books would devote at least one or two chapters of their work to this subject, it would no doubt be of great help to the average engineer, who is a reader of such text books.

Engine cylinder oiling may not have, as yet, been reduced to an exact science like brick laying, as one writer puts it, but at the present day of very high pressures and superheated steam, general practice demands a more general and thorough knowledge of steam cylinder lubrication. The subject needs thorough ventilation, and I know of no one who is truly more fitted (without it is an oil expert) to furnish such information than our present well posted and intelligent steam engineers, because they have during their past years of practical experience with different engines, speeds and pressures, had good opportunities of forming valuable opinions that would be of great benefit to young and less experienced engineers.

One engineer says, "An engine can be run entirely without any cylinder lubrication, and that the steam offers some lubrication itself." The engineer that can successfully run his engine without any cylinder lubrication, or who says he can, evidently holds an exalted place in the minds of some steam users whose oil barrel seems to loom up before them mountains high. No doubt it is quite true in some instances to so run an engine, especially so, if of the vertical type, for a considerable length of time without employing a lubricant of any kind in the cylinder, but in doing so it is based on conditions and provisions. Yes, I know! I can be cited to instances where engines have been run continuously for several weeks without lubrication except that furnished by the steam, and when examined found in good condition.

Naturally then, one would ask himself what is the use of putting into his cylinders from 40 cents to $1.50 worth of oil per day if they do not absolutely need it. Would any engineer, who has tried this, advise engineers in general to do away entirely with steam cylinder lubrication? No, I dare say he wouldn't, for in every case where it has been tried, they have returned to lubricating their steam cylinders, for it is too great a risk besides too much loss of power due to friction. Coming down to facts, "Oil is being used where the greatest efforts to secure the highest economy possible are constantly put forth and where serious damage to expensive cylinders has resulted from an unavoidable lack of oil. This fact, I should think, would be accepted as sufficient evidence that cylinder oil or its equivalent is necessary in preserving the proper conditions of the working surfaces. Nothing has been offered to the public or to engineers in general any way tending to show the frictional losses with, or without, cylinder lubrication."

Running engines without cylinder lubrication and without injury may be practical and possible, but the question with a concern, who has valuable machinery and their output rushed with orders, is not one considering only the possibility, but also the advisability of doing so. An engineer is taking upon himself a considerable responsibility when he does away with cylinder lubrication to lessen the operating expenses, for he is depriving the engine of its needs and that which he would first make use of if he found the cylinder and piston were cutting grooves into each other.

Back some years ago when the steam boiler was only required to carry from 30 to 60 pounds of steam per square inch and the engine only to make from 30 to 80 revolutions per minute, steam cylinder lubrication did not require the consideration that it does at the present day. Now, we have boilers carrying 350 pounds per square inch, and engines making from 75 to 500 revolutions per minute, and we must not forget, too, that some of our engines now use one, two, three, four and sometimes more cylinders.

At the time of such low pressures and low speeds "most any old thing" would do, like tallow and engine oil, but it won't do now. Suppose we look over these pressures and see how they range. The steam pressure by gauge of 30 to 60 pounds equals 45 to 75 absolute, their heat equals 259.3 degrees F. and 307.5 degrees F. We see readily that there is quite a difference in the degrees of heat at such comparatively low pressure, a difference of 48.2 degrees. Say then we took about an average of the pressures that steam plants carry today, say it is 140 pounds per gauge or 155 absolute; at this pressure the steam equals 361 degrees, a difference in degrees of this pressure and the one first mentioned, which equaled 259.3 degrees F.=101.7 degrees. Without going a word further, I would ask the intelligent engineer, Would a cylinder oil most suited for the engine cylinder whose boiler pressure was only 30 pounds be suitable for the engine cylinder whose boiler carries 140 pounds and having a higher piston speed? I say no. Well, this is just the reason then that correct and proper lubrication at the present day is so much more difficult and requires study and care.

I can cite the readers of this article to various plants that are in operation, quite up-to-date in pressures and class, where the owners think cylinder lubrication a small matter, and they will say to you, "Oh well, most any good cylinder oil will do, we see no difference." Insufficient lubrication is now known to mean not only annoying delays, wear and loss of power, but less economy and naturally a loss of money, which present competition cannot stand.

Once sperm oil was considered the standard lubricant, but it has given place to pretroleum products. At the present date there seems to be no standard, simply because, and it is true, there cannot be any standard for the reason that lubricating oils must be selected for the work to be performed. An oil lubricant must be composed of the proper elements to suit the existing conditions, by this we mean either hot, cold, internal or external surfaces, it must fill up the inequalities of the bearing surfaces with its globules, lift the opposing surfaces so as to interpose an innumerable series of microscopic but perfect "ball bearings." It must do this to be a perfect lubricant.

The disadvantages of oil lubrication are, that in order to lift the microscopic irregularities of the bearing up so that they will not rub and wear against the microscopic irregularities of the active surfaces, there must be maintained between the rubbing surfaces a layer of oil sufficient to prevent direct contact between them, and to maintain such a layer the material must be proportionally consistent. The greater the consistency, or in other words the viscosity of the oil, the thicker will be the layer between the rubbing parts, but to obtain the best results the oil should be as fluid as possible. It has been demonstrated by experts on lubrication, that there is a loss of lubricating power if the oil is too thick and there is also a loss in strength if the oil is too thin. There is no happy medium, for with increased viscosity or thickness there is a loss of lubricating power, and with increased fluidity there is an insufficient layer maintained between the rubbing surfaces. We readily see that proper steam cylinder lubrication is quite a problem, and we need more general information on this subject.

It is safe to say the amount of power expended uselessly in the average steam plant is practically an unknown quantity. The losses by friction in the engine cylinder should be measured and the cause be made the object of study and investigation. It is also needless to say that the quality of the lubricant and its adaptability to the requirements made of it in each case has a marked effect. The cylinders and valves require a certain lubricant in order to obtain the very best results and it generally happens that what is saved in the first cost, is lost by increased friction.

In regard to using superheated steam in cylinders, the oil consumption is found to be about the same as when the cylinder uses saturated steam. Of course, the quality of the oil differs somewhat, for with superheated steam the oil is subjected to a more severe heat. Formerly, when we had low pressures and low speeds, animal and vegetable oils were used mostly. When these oils were decomposed under the severe heat they generated acids, which corroded the surfaces of cylinders, it was also found when using condensers and returning the condensation to the boilers or when turning the exhaust into the feed tank, that these oils led to corrosion of the boiler plates. These objections were removed upon the introduction of a proper mineral oil in their stead, and from that time and with continued experience and experiments valuable results are now obtained.

The oil most preferable has a high flash point. The desideratum, however, is to secure an oil that will not vaporize too readily in the cylinder. As a rule, only flash tests are employed in choosing a cylinder oil, but this only shows the safety of an oil. It does not follow that an oil that has a high flash test or point has the least volatility or property of evaporating. Then the real test for a cylinder oil is, as to its volatility, the test being to expose the oil for some hours in an oven at a known temperature and note the loss of weight.

During the past four or five years there have been installed hundreds of compound engines having two or more cylinders. They usually employ high steam pressures and many of them using superheated steam. The compound engine always has two or more cylinders, at least one high and one low pressure cylinder. Now, if we only had the high pressure cylinder to lubricate similar to that of the ordinary high pressure single cylinder, non-condensing type we would be bothered no further when we were fully satisfied that this cylinder was being thoroughly and sufficiently lubricated, but we have another cylinder, and may be more, attached to our engine that must be well lubricated also. The question arises—Does the cylinder oil fed into my high pressure cylinder lubricate sufficiently my low pressure cylinder also? Right here engineers differ. One says, "No, I use in connection with the high pressure cylinder oil a low pressure oil, put through an ordinary lubricator and introduced directly into the low pressure cylinder." And another says, "I use the high pressure oil on both cylinders."

This practice is no doubt a wasteful one, and besides he would not get the benefit of his oil introduced into his low pressure cylinder. The use of both the high and the low pressure oil is much more commendable. It effects quite a saving and gives good results when carefully used, and if the oil is prepared to suit the existing conditions no doubt the very best results can be obtained.

It has been said that the most economical lubrication for the compound engine of two or more cylinders, is to use one oil, a compound oil. In this case, it must surely contain the very elements essential to the existing conditions, and the engine must be under the management of an operator perfectly familiar with the elements of his compounded oil, the existing con-

ditions, and every detail of the requirements of his machines. This form of lubrication is possible, but with the little knowledge the average steam engineer possesses of oils and their elements, I might say, it is impractical.

The subject of lubrication is an attractive one and I hope the day is not far distant when this subject will be reduced to a science and thoroughly understood by the average steam engineer.

J. T. M.

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Books and Publications

"Armature Windings of Direct Current Dynamos." By E. Arnold. Translated from the Original German by Francis B. De Gress. The D. Van Nostrand Company, 23 Murray Street, New York. Price, $2.00.

The author has endeavored in this work to present a general rule which applies equally well to ring, drum and disk armature winding for direct current machines, and by means of which the properties of the various windings may be accurately observed, and any desired winding designed to meet required conditions.

The book contains 146 diagramatic illustrations of numerous types of windings.

Many of the designs shown are of historic interest only, but are valuable from the fact that the principles expressed are fundamental.

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"Self-Propelled Vehicles." Their Theory, Construction, Operation, Care and Management. By James E. Homans, A.M. Theo. Audel & Co., 63 Fifth Ave., New York City, Publishers. Price $5.00.

For the owner, operator, repairer or intending purchaser of a motor-driven vehicle, this work is written in such a practical and untechnical manner that it will be of untold interest and quite comprehensible to the novice.

Motor carriages of all powers are coming increasingly to the notice of the public generally, as permanent features of present-day life. Although the industry is still young, and in many respects in a tentative condition, the best informed authorities agree that the principal features of construction are already established. This fact renders a thorough treatise on the subject both possible and desirable, without fear of giving an undue prominence to any constructions that may presently be superseded.

The construction and operative principles of the several types of vehicle motor-steam, gasoline and electric are treated. Under the head of steam engines, is given a very full and complete treatment of the various types of steam generator—fire-tube, water-tube and "flashing"—and the advantages involved in the use of each in turn, with the several features used on steam carriages for securing the ends of quick steaming and immunity from explosion. The important subjects of "boiler-feeders and water-level regulators" and of "liquid fuel-burners and feed-regulators" are next treated in the course of two extended and fully illustrated chapters, in the course of which the theories of the principal well-known devices are fully explained. In order to render the work, as far as possible, a "practical hand-book," the theory of the steam engine is set forth in accord with the several laws governing the generation and use of steam, and the familiar constructions of valves, link-motions, etc., by which these are practically applied.

The exhaustive character of the work may be judged from the fact that its forty-five chapters occupy 640 pages, embellished with nearly 500 illustrations and diagrams, covering nearly every type of practical device used on motor-driven carriages. Several useful tables are included in an appendix, and the book is closed with a very full and carefully prepared index.

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"The Electrical Catechism." A book of 210 pages, containing 533 Questions and Answers. Published by the Hill Publishing Co., New York. Price, $2.00.

This work is compiled from the Questions and Answers which appeared in serial form in "Power," and is profusely illustrated.

The author has endeavored to limit the discussion to such branches of electrical work as may be considered to come within the range of the average engineer.

Seven of the fifteen chapters are devoted to alternating currents, alternating current generators and apparatus, the daily increasing use of which and the comparative scarcity of appropriate literature on this important branch of the subject, the clear and concise manner in which the various branches are treated, together with the explanation of technical terms in every day phraseology, should make the work a valuable acquisition to any one interested in the care and management of electrical apparatus.

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Mechanical Index, Section A, a list of manufacturers of machine tools and metal working machinery, published by the Industrial Press, New York. Price, $1.00.

This is the first section of a work which when completed is intended to be an encyclopedia and list of manufacturers in the United States of mechanical appliances and tools operated by steam, electricity, water, air or foot power; carefully arranged under sub-headings for quick reference. Other sections will follow as quickly as they can be compiled and printed, and when the sectional issues are completed, they will be revised and bound together in one book containing about 600 pages. The object in issuing the work in sections is to reach thoroughly those who are interested in each particular section, and to obtain all the corrections possible in the different lists before publishing them in book form.

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Items of Interest

Dr. Arsene d'Arsonval, of the Paris Academy of Sciences, is credited with the discovery of a method of extracting from ordinary pretroleum oil a fluid that will not congeal even at a temperature of 205 degrees below zero. According to reports published, this "petroleum ether," as it is termed, is declared by Dr. d'Arsonval to be of great value, especially in scientific research, permitting the construction of theremometers of a greater precision than any hitherto made. It is also proposed to utilize this material as a cooling agent for refrigeration of dwellings, offices, ships' cabins, etc.—*Ice and Refrigeration.*

QUESTIONS AND ANSWERS.

THE editor will be glad to receive from the readers of THE PRACTICAL ENGINEER, such questions relating to engineering subjects, as may, from time to time, occur to them. All questions and answers should be addressed to the editor and accompanied by the name and address of the writer, which will not be published, however, unless especially desired. It is the intention that questions shall be answered by the readers, and even though the editor may, from time to time, publish answers with questions, he especially desires the readers in such cases to contribute any further information in connection with the points raised, that they may consider of interest. All questions and answers received by the editor will be published, as far as practicable, but he reserves the right of editing or rejecting any communications.

Editor PRACTICAL ENGINEER:

I received my first number (May) of your most valuable paper, which I consider the best paper treating steam engineering for the money. I wish I were a citizen of the United States, as I would readily become a member of the A. O. S. E. While perusing your columns of Questions and Answers, in answer to a contributor (J. Luther) you gave him a rule to find the contents of a tank in gallons, which I think is incorrect. I am sending you the rule I use, and beg of you to publish same for the benefit of others.

How many gallons would a tank of the following dimensions contain? Bottom diameter 8 ft. 5 in.; top diameter 7 ft. 8 in.; height 5 ft. 2 in.

I find the average diameter thus: 8′ 5″+7′ 8″÷2=8′ 1″ or 97 in. Average diameter 97 inches. 97″ x 3.1416=304.8 in. The dimentions of the tank if square would be 76.2 in. for each side of square. This I find by dividing the circumference by 4. 304.8″÷4=76.2″. Since my tank is now square, to find the contents in cu. in. I multiply the length by the width and by the height.

76.2″ x 76.2″ x 62″=359,999.2 cu. in. Dividing by 231 the number of cubic inches in a gallon I have 1,558.4 gallons capacity of the tank. I have used this rule in my factory to find the gallons contained in kegs and milk cans, vats, etc., and found same accurate.

LOUIS BRODUR.

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Editor THE PRACTICAL ENGINEER.

In the April issue your answer as to the relation between H. P. Watt and Kilowatt is not exactly correct as I see it. The watt is the product of the volt and ampere, and is the electric unit of power; it is equal to .7373 ft. pds. per sec., or to 44.24 ft. pds. for one min.

The K. W. is 1,000 watts and is equal to 737.3 ft. pds. per sec., or 737.3 x 60 mims. equals 44,240 ft. pds. per min.

Hence as one H. P. = 33,000 ft. pds. per min. A. K. W. = 44,240 ÷ 33,000 = 1.34 H. P. (instead of 1.2 H. P.)

Thus to find the Elec. H. P. generated by the dynamo at 600 amps. and 110 volts = 660,000 watts or 66 K. W. And since a K. W. is 1.34 H. P. 66 K. W. = 66 x 1.34 = 88.44 E. H. P. (instead of 79.2 mech. H. P.)

To convert H. P. into watts, reduce H. P. to ft. pds. per min. and divide by 44.24.

Thus 88.44 H. P. x 33,000 = 2,918,520 ft. pds. per min. ÷ 44.24 = 660,000 watts or 66 K. W., very nearly, the difference being due to decimal frac. employed.

The article referred to might have been due to typographical error, but any way is apt to mislead a novice.

J. C. NEVILLE.

We appreciate very much the above correction and wish to express our thanks to any and all of our readers for the interest they display in the study of our columns. We herewith append a correct table of electrical expressions.—Editor.

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ELECTRICAL EXPRESSIONS

And Their Equivalents. Arranged for Convenient Reference.

One WATT	A RATE of doing work 1. ampere per sec. at one volt .7373 foot-pounds per second 44.238 foot-pounds per minute 2654.28 foot-pounds per hour .5027 mile-pounds per hour .00134 Horse-Power $\frac{1}{746}$ Horse-Power
One KILOWATT	A RATE of doing work 737.3 foot-pounds per second 44238. foot-pounds per minute 502.7 mile-pounds per hour 1.34 Horse-Power
One HORSE-POWER	A RATE of doing work 550. foot-pounds per second 33000. foot-pounds per minute 375. mile-pounds per hour 746. watts .746 kilowatt
One WATT-HOUR	A QUANTITY of work 2654.28 foot-pounds .503 mile-pounds 1. ampere hour per one volt .00134 Horse-Power-Hour $\frac{1}{746}$ Horse-Power-Hour
One HORSE-POWER HOUR	A QUANTITY of work 1,980,000. foot-pounds 375. mile-pounds 746. watt-hour .746 kilowatt-hour
One AMPERE HOUR	A QUANTITY of current One ampere flowing for one hour, irrespective of the voltage Watt-hour volts
TORQUE	FORCE moving in a circle A force of one pound at a radius of one foot

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Editor PRACTICAL ENGINEER:

Will you please give me rules for finding the horse-power of a belt; also tell me the power of a five-inch single belt running on a pulley 24 inches in diameter at a speed of 150 revolutions?

L. M. W., Philadelphia.

You will find the following tables and rules correct in obtaining the power of belts of the average good quality. While it does not give you the power of the size belt you have mentioned at 150 revolutions, you can determine from this table approximately the power of any size belt.

Your pulley =24″ diameter=75.39 circumference. At 150 revolutions per M. attains a speed of 942.37 feet, 1.42 horse-power per inch in width of belt=5 x 1.42=7.10 horse-power transmitted by your belt.

The ultimate strength of ordinary bark-tanned single leather belting varies from 3000 to 5000 lbs. per square inch of cross section. For convenience sake the tenacity is stated generally in pounds, per inch of width. For single belts the breaking stresses are from 750 to 1250 lbs. per inch of width. For double belts the breaking stresses are from 1500 to 2500. Allowing for joints this is reduced to about one-third of the strength of the solid leather and allowing a factor of safety of 5, we get a safe working stress of 1-15 of the breaking stresses of the solid leather.

For single belts the working tension would be from 50 to 80 pounds.

For double belts the working tension would be from 100 to 160 pounds.

In practice, however, 50 lbs. for single and 80 lbs. for double belts per inch of width are considered about the maximum. Under these conditions leather belts will run for many years.

EFFECT OF CENTRIFUGAL FORCE ON BELTS.

When belts or ropes are run at high speeds the tensions in the two parts of the belts or ropes between the pulleys are greater than that calculated from the horse-power transmitted. This increase of tension is due to the centrifugal force set up in those parts of the belt which are in contact with the pulleys.

The centrifugal force has the effect of diminishing the normal pressure between the belt and the pulley and, therefore, of diminishing the resistance to slipping.

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Horse Power that Leather Will Transmit Per Inch In Width At Various Speeds.

Velocity of Belt in Feet Per Minute.	Best Oak Tanned Belts.		
	Single.	Light Double	Heavy Double
100	.15	.21	.27
200	.30	.42	.55
300	.45	.64	.82
400	.61	.85	1.09
500	.76	1.06	1.36
600	.91	1.27	1.64
700	1.06	1.49	1.91
800	1.21	1.70	2.18
900	1.37	1.91	2.45
1000	1.51	2.12	2.73
1100	1.67	2.33	3.00
1200	1.82	2.55	3.27
1300	1.97	2.76	3.55
1400	2.12	2.97	3.82
1500	2.27	3.18	4.09
1600	2.42	3.39	4.36
1700	2.58	3.61	4.64
1800	2.73	3.82	4.91
1900	2.88	2.03	5.18
2000	3.03	2.24	5.45

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Editor PRACTICAL ENGINEER:

I have a 500 horse-power Greene engine running under, please let me know the easiest manner of changing it to run over? The engine runs nice and steady sometimes and sometimes it races badly; I have taken the governor apart and find that it is in good shape. Could it occur through a belt slipping in some part of the mill or is the fly-wheel too light?

H. W., Philadelphia.

The proper manner of changing your engine over should be with the use of the indicator, however, it can be done as follows:—Place engine on dead centre (either will do), then take a straight edge and make a line running perpendicular on the steam eccentric slide and stationary bars, then loosen eccentric (steam) and roll it around, in the direction you wish the engine to run, until the lines are in the same position again, in other words, you move the eccentric 180 degrees minus twice the angle of advance and then fasten. Then place engine on the same centre and carefully observe the line which is cut in the small cross head of the exhaust valves. Take a pencil and continue the lines straight down upon the moving part; loosen exhaust eccentric and roll around in the direction engine is going to run until the lines cross again (or meet) then fasten eccentric.

There are two or three more complicated rules for attaining this result, but by carefully observing the above conditions you will have your engine set under the present conditions, only in the opposite direction.

Concerning the racing. We would advise you to examine the governor belt, if it slips your engine will race badly. If you find no trouble there you will find most likely that the oil in the governor dash-pot has become stiff, all the volatility having evaporated from it, in which event the action of the governor is retarded in moving either way; when the balls are down the engine will race badly before they can gain their proper place, owing to the stiffness of the oil; the same action takes place in case of a sudden lightening of the load. It would be well to renew the oil in the dash-pot.—EDITOR.

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The Leonard High Speed Multiple Cylinder Engine

The accompanying illustrations show the Leonard High Speed Multiple cylinder engine. The most important features of this engine is its extreme simplicity and regularity of its action, thus making it invaluable to users of light power electrical generators. It can be direct connected to the generator in a space that would be impossible to attempt with the usual engine of like power.

The parts are easy of access and are of such simple design throughout that the average person will find but little difficulty in making repairs.

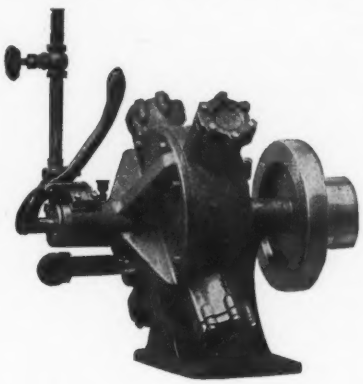
Figure one shows the complete engine as used for stationary purposes. It will be seen that the frame, cylinders and bearings are all cast in one piece. There are four cylinders, single

acting, set at right angles to the crank shaft, which it will be seen is made of a solid piece of steel. The four pistons which are of the oscillating type, direct connected, are connected to the crank shaft in an ingenious and practical manner; this permits of the most perfect balancing, and, owing to the arrangement of the cylinders, the strain on the crank pin is constant, as one cylinder is always under pressure. Thus it will be readily appreciated that the motion obtained will be certain and regular.

The valve gear is rotary and is alike with the rest of the construction, very simple. It is operated by a disc, as shown in cuts Nos. two and three. This valve is controlled by a lever having a rachet stop. By this arrangement, the motion

of the crank shaft can be reversed at the will of the operator. The supply of steam can be regulated by the same movement. This is a featnre which will at once appeal to the users of detached machinery, pumps, fans, etc., the greatest economy being made possible.

The method of operation is as follows: Steam is admitted



to the side of the valve frame, passing through the ports in the valve to the tops of the cylinders; from thence it is exhausted back through the same valves to an exhaust chamber in the valve casing; from there to the exhaust pipe.

The wearing parts are bronzed bushed and can be readily replaced.

Among the many features of interest are those of the ease

of lubrication and the fact that the engine can be started from any point, either right or left, at the will of the operator. The uses to which an engine of this sort can be put are manifold. They are now being used with evident advantage in working turn-tables, draw-bridges, forced draught-fans, light dynamos, automobiles, launches and farm and dairy machinery. An inquiry addressed to Joseph E. Wise, sole agent, Bourse Building, Exhibition Department, Philadelphia, will gain further particulars concerning the prices, power, etc.

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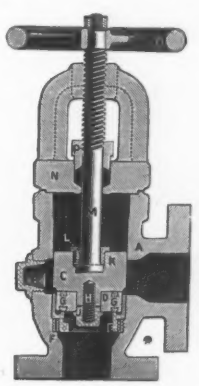
The Duro Blow-Off Valve

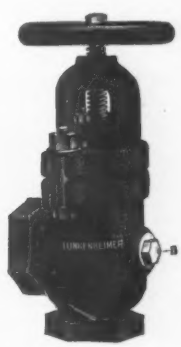
Blow-off valves have probably given more trouble than any of the other fittings which are part of boiler equipment. Many kinds have been offered upon the market which are claimed to possess the chief requisite in valves of this kind, i.e., durability; but, in service, they all appear to lack this essential feature. The Lunkenheimer Company, Cincinnati, Ohio, have made blow-off valves of various kinds for a great many years and fully appreciate the difficulties that have been encountered in designing a really satisfactory valve. While they have made several varieties and types which have given fair satisfaction, their search for a really durable construction has not met with success until within the past two yerrs.

Referring to the illustrations herewith it will be seen that the general form of this new valve (which they have designated by the trade name "Duro") is quite similar to the iron body angle blow-off valve which has been so extensively used for some years past. The object of this improved valve is to include whatever merits the old-style valve possessed, and, in addition, a distinctive feature, the novelty of which will at once impress users of its practicability.

Heretofore, in all makes of blow-off valves, the seat was so located that as the disc approached same there would be an accumulation of scale and sediment. The effect of this accumulation would be to cut out the bearing surfaces to such an extent that in a short time the valve would become leaky. Various methods have been invented whereby the disc would fit tightly in the valve body, the object being to prevent the scale from passing on to the seat bearing after the disc had passed and cut off the inlet. This method, however, has not proven satisfactory, as the valve body would soon wear, and, in a short time, permit the passage of scale and sediment. In the "Duro" valve these defects have been overcome. The plug fits snugly in a separate and easily removable bronze casing, which can be readily replaced when worn. Any accumulation of scale or sediment that might remain on the seat before the disc is brought in contact with same, is washed off by the water which passes around the plug when seating.

In the sectional view it will be seen that the plug C carries a reversible double-faced disc D, secured to plug C by stud H and nut J. This plug C is guided perfectly in the valve body A. The bronze seat ring E is screwed into a second brass ring F, the object of this being to make it possible to renew E





very easily in case same is worn. At the back of the valve is a plug B, the use of which is to permit the introduction of a rod to clean out the blow-off pipe when desirable. The stem M which raises and lowers the disc C is held in place by lock nut L, which is prevented from unscrewing by non-rotating washer K. It will be seen from this description that all parts of the valve have been so designed that they can be easily renewed when worn or broken. The disc D, having two Babbitt-faced bearings G G, it can be replaced at small cost, or the user of the valve can melt out the old Babbitt and pour in new metal, and, after this is faced off, the disc is as good as new.

In operating the "Duro" valve, when it is desirable to close same the disc is screwed down in the usual manner. As the edge of the disc D approaches the cylindrical extension of E these edges shear and cut off any scale or sediment which might pass. As the disc D continues to approach the seat bearing E, the leakage of water around same will effectually wash off any scale or sediment which might have accumulated thereon.

The result of this is, that when the disc is perfectly seated no scale or sediment can remain between the bearings. In all other makes of blow-off valves there is no provision made for washing off the seat bearing or renewing the part E, which, in time, will be worn by the shearing of the disc D when cutting off scale and sediment. As both of these parts can be renewed very easily and at small cost, it will be plain that the valve is very durable and will last indefinitely. These parts can be supplied promptly and at small cost.

All parts about the valve are very heavily and substantially constructed, and, all things considered, is one of the best and most substantial blow-off valves ever placed on the market. It has been in practical use and tested under every variety of service for almost two years and its practicability has been established beyond question.

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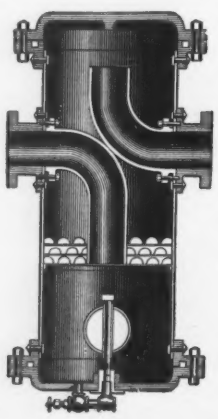
The Lindstrom Steam and Oil Separator

A steam separator combining in its construction an oil separator and a steam trap will appear to most engineers in the nature of a novelty, but in the Lindstrom Steam and Oil Separator the observing engineer will find many points of interest and value.

When oil enters a boiler the particles coalesce to form an oily scum on the surface or float above, in separate drops, but show no tendency to sink, owing to their light weight, when, however, they come in contact with solid particles of sediment they adhere, coating them with oil, in this way the oil is loaded until it is carried along by the current of water and deposited upon the surface of the shell or flues. These deposits are very poor conductors of heat, and experiments have shown that when they attain a thickness of one sixty-fourth of an inch, the plate is endangered. This will be sufficient to raise



the temperature of the plate until the oily deposit begins to decompose, giving out gases which blows up the greasy layer into a spongy mass, the plate being much overheated, may become red hot and collapse, sometimes the oil coalesces into cakes, which when sufficiently loaded with lime sinks and locates upon the sheet, the result is sometimes the formation of a bag or pocket.

The Lindstrom Separator was designed for the purpose of removing all oil, grease and other impurities from the exhaust steam and in that way remove the heretofore great objection to using the condensed water over again in the boilers, or for other purposes.

Another feature of merit is that it can be used in connection with a condenser for condensing engines without loss of vacuum. A careful study of the accompanying illustrations will show the method by the impingement of the steam upon the bars, having cross sectional form of a tube, and spaced apart so as to leave an opening between the edges of the adjacent bars. The openings are so proportioned and placed that undue friction or loss of pressure, through steam cushion will not be occasioned. The number of separating bars inserted are determined by the requirements.

The automatic trap, as shown in the illustration, is in the lower chamber of the separator and is of the very simplest construction, having no pins, joints, screws, etc., to become deranged. As the oil trickles down from the separating bars and rises in the separator chamber the copper float will unseat the escape post valve placed in the tube above the bashing, and in this manner discharge all oil and water in the chamber.

The movement of the trap is entirely automatic, and being in combination with the separator, does away with the necessity of purchasing separate steam traps. The satisfaction this appliance has given those now using it demonstrates that it is all that is claimed for it. A further description and catalogue can be secured from John Lindstrom, 440 Liberty street, Allentown, Pa.

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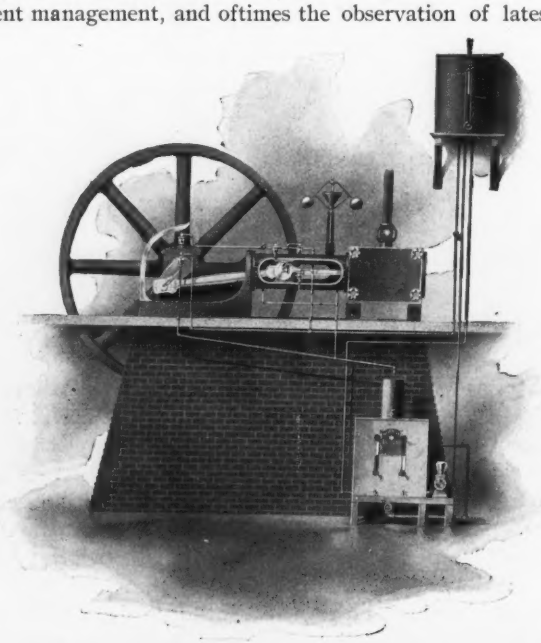
Modern Lubrication of Engine Bearings

In the construction of a power plant, the intending builder, in order to obtain the greatest possible economy in operation, either procures the advice of competent counsel, or embodies in the structure and installation of the necessary equipment, the observation of years of experience as to what seems most suitable for the requirements.

The concentration of both economy in first cost and future maintenance of a power plant, is a most essential feature in these days of strenuous activity and is the determining factor between success and failure. Constant study is required, embodying extensive practical experiment, combined with intelligent management, and oftimes the observation of latest de-



WHITE STAR OIL FILTER, APPLIED TO A CONTINUOUS OILING SYSTEM

vices, as installed by others, with the result that the maximum efficiency, both from an economic and engineering standpoint,

is only attained through the employment of the latest approved methods and appliances.

The boiler room of to-day when compared with that of a decade ago has become revolutionized, while the engine room has kept pace in the perfection of its complement in most every particular, however, a most important feature towards the end of attaining the maximum in the economical operation of machinery, has until recently been neglected—that of the automatic lubrication by mechanical means of main engine bearings, slides, eccentrics, crank-pins, etc.

This problem has been most successfully solved in an effectual manner by the White Star Gravity Filtering System, employing the duplex and multiplex types White Star Oil Filter, as designed and installed by the Pittsburgh Gage & Supply Company, Pittsburgh, Pa., with Eastern office at 1011 Girard Trust Building, Philadelphia, and illustrated herewith.

A proper conception of the advantages of such an equipment will be gained when it is understood that a complete pipe system for oiling dispenses with 80 per cent. of the labor for attention by automatically handling all the oil applied to or released from the machinery, reducing to a minimum both the loss by friction, and its attendant expense for repair, in continually supplying the bearings with an abundance of oil, while waste in handling the oil in cans by hand oiling is entirely obviated.

DUPLEX TYPE, WHITE STAR OIL FILTER

In addition to this a remarkable saving in the cost of lubrication is effected by the White Star Filter which purifies the oil discharged from the machines, delivering it again to the system in perfect condition for use over and over again.

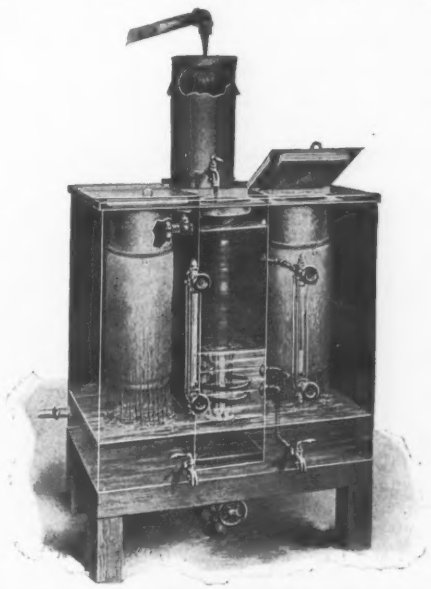
In the entire process, the only loss of oil is from vaporization as the pipe system prevents all waste.

The oil is fed to the several cups by gravity, from the elevated reservoir, and, after passing through the bearings is carried in piping to the filter where it is purified and returned by the pump to the storage tank above. The third pipe carries any surplus back to the filter and prevents overflow.

The supply of oil is thus continuous and uniform.

The operation of cleaning the oil is one of interest, and may be seen in the sectional view accompanying. The impure oil enters the auxiliary tank on top of the main body, and is drained through removable screen, passing out through spigot into funnel, also provided with screen, and suspended in the central compartment, and finally discharging out through the perforated conical foot of funnel, into water kept at a moderate temperature by means of the steam coils shown. By continued action of the heat, the oil becomes thinned, and all water and heavy impurities are rapidly separated from it by gravity, and the former being automatically carried off by an overflow pipe at the back, and the latter accumulating at the bottom of the chamber are flushed out occasionally through a drain connection.

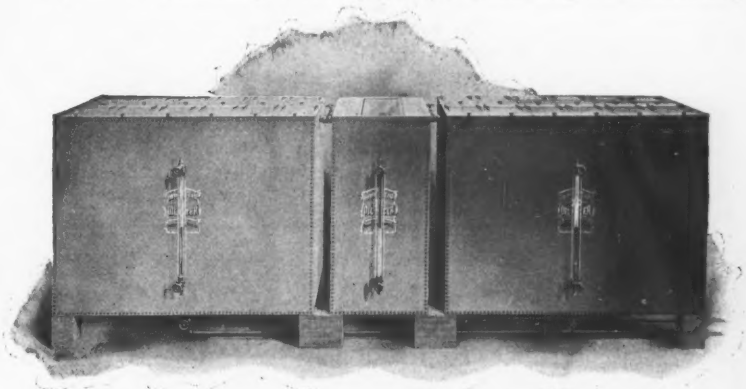
The constant admission of oil to the separating chamber



SHOWING METHOD OF OPERATION AND CONSTRUCTION, DUPLEX TYPE, WHITE STAR OIL FILTER

eventually causes the oil to reach the level of the outlets near the top and flow into the adjacent filtering cylinders. Specially prepared cloth is wrapped around these cylinders, and in the passage of the oil through the body of the cloth, the oil is freed of impurity not previously eliminated by gravity, and is thus prepared for continued use.

A beautifully booklet copiously illustrating and describing



MULTIPLEX TYPE, WHITE STAR OIL FILTER, FOR LARGEST POWER STATIONS

the White Star Filtering System, together with the process of oil filtration, citing in detail the advantage of such equipment will be sent by the Pittsburgh Gage & Supply Company, 308 Water Street, Pittsburgh, Pa., to those interested.

TRADE NOTES.

A New Catalogue has been issued by the Philadelphia branch of the Garlock Packing Co., 604 Arch Street, showing good illustrations and ably describing all the various styles of packings made by that company. In addition to packings, several other steam specialties handled by the Philadelphia house are shown, including Gilbert's Self-Packing Gauge Glass Preserver, Grady's Metal Polish, Garlock's Belt Preservative, etc. A copy of the catalogue or a sample of either the metal polish, or the belt preservative, will be sent upon request.

Recent Sales of the engineering department of the Pittsburgh Gage & Supply Co., Pittsburgh, include two 350 horse-power water tube boilers, with stokers and coal conveying apparatus, for the Montrose Pumping Plant, Allegheny City, Pa.; eight stokers for the Allegheny City Light Plant; a 1000 horse-power Patterson-Berryman Water Heater for the Whipple Colliery Co., as well as a 125 horse-power P.-B. water heater for the Lake Erie Limestone Co.

James McCrea & Co., 67 West Washington Street, Chicago, Ill., have recently placed the New England Agency for their Climax Steam Joint Clamps with A. W. Chesterton & Co., of Boston, who carry a large supply of the clamps in stock, and can fill orders at a moment's notice. Any of our New England readers who are troubled with leaks in their steam pipes—of any size—will do well to try these clamps.

The Burt Mfg. Co., of Akron, Ohio, have recently made a large shipment of Gross Oil Filters to London, England. The question is suggested that if their oil filters save half on a manufacturers' oil bill, as they advertise, how long will it take for them to save enough to pay for the Boer war?

John T. Lindstrohm recently did a job of engine repair work which we think has rarely been equalled for speed. He bored a 44″x48″ cylinder, two cuts, and bored out the exhaust valve pockets of an engine in the Brookside Cotton Mills, at Knoxville, Tenn., from 9 o'clock in the morning until 7 P. M. By 12 P. M. the engine was running and did not stop until quitting time the next evening.

A Good Name may be more desirous than great riches, but in some cases the former is practically equivalent to the latter. At least this appears to be true of Thomas Walker & Sons, manufacturers of Walker's Famous Metallic Packings. These packings have been before the engineers of the country now for some twenty years and each year the increasing demand testifies to their growing popularity. A recent visit to their establishment showed the works to be running full handed night and day with a large number of advance orders in hand, the result of a good name.

The Peerless Specialty Co., 1720 North Fifth Street, Philadelphia, report a constantly increasing demand for their specially prepared chemicals for purifying feed water. They claim to not only remove scale from any boiler, but to prevent its formation in every case regardless of what the composition of the feed water may be.

Enormous Orders have recently been received by the Liberty Mfg. Co., of Pittsburgh, Pa., for their Turbine boiler tube cleaners. Considering these, together with the fact that this cleaner has been on the market now for several years, seems to indicate that it's a pretty good cleaner.

A Handsome Catalogue and one of more than ordinary interest to engineers, has just been published by the E. J. Moore Machine and Foundry Co., 2227 Wood Street, Philadelphia. The cover is one of the richest bits of printing that we have seen recently, and the descriptive matter is of special interest because of the fact that it was principally prepared by Mr. E. J. Moore, who was the practical originator of water tube boilers. A copy of the catalogue will be sent upon request.

A Free Sample of Stephenson's Bar Belt Dressing is good value for a postal card addressed to the Stephenson Mfg. Co., Albany, N. Y.

Mr. John A. Schill, one of Philadelphia's popular steam specialty salesmen, who has been before the engineers of this city for a good many years, and has made hosts of friends, has recently accepted a position with the Fairbanks Co., Seventh and Arch Streets, where he is in charge of a line of high grade specialties, including Cross Oil Filters, "Easy" Projectors, Semi-Bronze Packing, etc.

CROSS OIL FILTERS

DEPARTMENT OF EDUCATION
City of New York

Burt Mfg. Co., AKRON, O.

Gentlemen:—I beg to state that I am now specifying your Oil Filters for the New York Schools and will probably place several of them during the coming year. The one you sent on trial is doing good work and is very satisfactory.

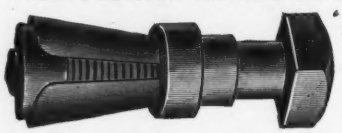
Yours truly
WM. M. MANNIS, Eng'r.

Cross Oil Filters save and satisfy. They give uninterrupted good service with so little attention that every man who buys one will class it among the best investments he ever made.

We sell on 30 days' trial with privilege of return at our expense if unsatisfactory.

THE BURT MFG. CO., Akron, Ohio, U. S. A.
Largest Manufacturers of Oil Filters in the World
Cross Oil Filters carried in stock by the
FAIRBANKS CO.,
Sole Agents for Philadelphia

THE POSITIVE EXPANSION BOLT



Special Discount to Jobbers. Write for Prices

Manufactured by **D. C. SEAMAN & CO.**
1638 Hutchinson St., Philadelphia, Pa.
For sale by Neal & Brinke 18 Warren St., New York; Somers, Fiths & Todd Co., 323 Water St., Pittsburgh, Pa.

IF ENGINEERS will send $1.00 to the address below they will receive two blue prints, with tables and instructions, showing how to set valves and eccentrics on Corliss engines, simple and compound, with one and two eccentrics. JOHN T. LINDSTROM, 440 Liberty Street, Allentown, Pa.

DO YOU KNOW

That we manufacture chemical water purifiers that are guaranteed to prevent and remove incrustation in steam boilers, no matter what its composition may be.

CHEMICAL PURIFIERS

that do this without injury to the boiler, its fittings or connections;

CHEMICAL PURIFIERS

that can be used with perfect safety in Breweries, Ice Plants, Dye Works and all places where the water of condensation is used for any purpose.

Write for terms, reports, circulars, etc. We interest you and pay liberal commission. Agents wanted everywhere.

THE PEERLESS SPECIALTY CO.
1720 N. 5th St. and 1711 N. Randolph St.
Philadelphia, Pa.

THWAITES & HORNER
ELECTRICAL CONTRACTORS

Engineering, Contracting, Repairing. Thwaites Intercommunicating Telephones. New Edison Phonographs. Hard Molded Records. Louder and Sweeter than the old Wax Records.

Phone 3-48-14 **1215 FILBERT STREET, PHILADELPHIA**

The Allis-Chalmers Co. have placed an order with the Pittsburg-Gage & Supply Co., Pittsburgh, Pa., for a complete White Star Filtering System, to be applied to two of their engines destined for improvements in the plant of Jones & Laughlins, Ltd.. Pittsburgh, Pa.

"Worth Knowing."—We are just in receipt of a booklet from the Keystone Chemical Manufacturing Company, of Camden, with this rather unique title. A careful reading of which, shows the application of the title to the contents. The book not only describes their product, TRI-SODIUM PHOSPHATE and BOILER COMPOUNDS, its effect upon feed water, clearing and purifying it before entering the boilers, its action in preventing scale, and the dissolution of same where formerly deposited, but it gives a large variety of useful information pertaining to steam and kindred topics that are well worth knowing to those interested in this subject. TRI-SODIUM PHOSPHATE has the full endorsement of the leading Boiler Insurance Companies. The book is not for general distribution, but is sent free to steam users in general, particularly to the chief engineers interested in securing the best results for their boilers.

The old original Berryman Feed Water Heater, sold by Mr. Thos. McAdoo, 125 North Fourth Street, Philadelphia, seems to hold its own. Mr. McAdoo reports some very large sales recently, exceeding any former sales.

Mr. Oliver Braden, of the Cherry Chemical Co., Philadelphia, recently returned from a trip to the Pacific Coast, where he reports having sold large quantities of Red Seal boiler compound to railroad and mining companies.

The Electro Dynamic Co., 212 Ionic Street, Philadelphia, are keeping constantly busy in their repair department where they make a specialty of all kinds of repairs to dynamos, motors and other electrical apparatus. Local engineers who have work of this character will do well to give them a trial.

FOR SALE.—Thompson Steam Engine Indicator, 8 springs, reducing motion and scales. Perfect condition. Price reasonable.
T. D. Brown, 780 N. 26th St., Philadelphia, Pa.

FOR SALE.—A new Morse and Dexter Valve Reseating Machine in perfect condition, very cheap. Address "A. H.," care of The Practical Engineer, 1215 Filbert Street, Philadelphia.

The Standard Electric and Elevator Co., 116 S. Seventeenth Street, Philadelphia, have established a thoroughly equipped department for repairing elevators of all styles and makes. They also manufacture and install new elevators for every service. Their Mr. Samuel Marks will be pleased to call upon any of our local readers desiring estimates.

The Lagonda Mfg. Co., of Springfield, Ohio, have received a letter from Mr. Chas. F. Stirely, superintendent for the Syracuse Rapid Transit Co., stating that the mechanical tube-cleaner purchased from them will clean a 4″x20″ tube that is filled full of hard scale, in seven minutes, also that the machine cleaned 528 4″ tubes from 18″ to 20″ long without one cent for repairs. This seems to be worth investigating.

BOWERS BROS. & CO.

Contracting Engineers for HEATING and VENTILATION SYSTEMS, by Steam or Hot Water. FAN SYSTEM. PIPING POWER PLANTS.
Also Manufacturers of GRATE BARS of all descriptions. GENERAL CASTINGS.

1021 REAL ESTATE TRUST BUILDING
PHILADELPHIA, PA.

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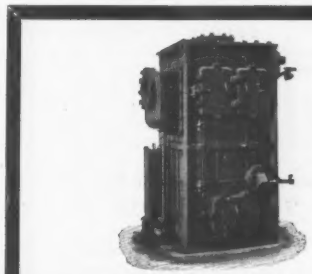

COCHRANE HEATER

Even If You Have Money to Burn-- DON'T BURN IT

A man who lets his engine exhaust free to the air and pumps cold water into his boilers, or feeds his boilers with a live steam injector, is simply wasting his money.

If he used his exhaust steam to heat his feed-water, each 10° added to the temperature of the water would save 1 per cent. of his entire fuel bill.

Given the necessary exhaust steam, the

COCHRANE FEED-WATER HEATER AND PURIFIER

will heat water of any temperature to practically the boiling point. The average initial temperature is, say, 60°; difference between 60° and 210°=150°—a saving of 15 per cent. in fuel (1 per cent. for each 10°). In a year this saving would pay for the heater several times over—and a few other things beside.

Then the Cochrane Heater saves water—usually over 14 per cent. of the total supply required—by conserving the condensed exhaust steam, which, being distilled water, is free from scale-forming matter. There are other advantages of the COCHRANE described in catalogue 16-H. Write for it.

HARRISON SAFETY BOILER WORKS

3144 North 17th St., PHILADELPHIA, PA.

MANUFACTURERS OF
Cochrane Heaters
Cochrane Separators
Representatives in all leading cities

YOUR BELTS

YOU DON'T WANT TO RUN TIGHT BELTS. DO YOU?

YOU HAVE TO. WE KNOW YOU DON'T BELIEVE IN BELT DRESSINGS. WE DON'T BLAME YOU.

BUT YOU WILL BELIEVE IN CLING-SURFACE if you will investigate what it will do.

It penetrates a porous belt and leaves the surface clean—not sticky.

It preserves the belt, stops all slipping, so the belt can run easy under full load. This isn't what we say, it's what our customers say. We will show you if you wish. Get a package, test it, pay only if satisfactory.

CLING-SURFACE MFG. CO.,
185-191 VIRGINIA ST., - - - BUFFALO, N. Y.

NEW YORK—39-41 CORTLAND ST.
PHILADELPHIA—THE BOURSE.

EVERY belt in use loses some of its power by slipping. The only way to restore its grip on the pulley is by reproducing the conditions of a new belt. Dixon's Belt Dressing gives a belt its original freshness, gives it a renewed lease of life, and a renewed hold on the pulley. It doesn't spoil the belt. It improves it and prolongs its life. Sample free.

JOSEPH DIXON CRUCIBLE COMPANY
JERSEY CITY

American Order of Steam Engineers.

ORGANIZED APRIL 27, 1886.

An Order of Engineesr for Engineers and Engineers only.

DECLARATIONS OF PRINCIPLES

Believing that ability will bring its full value in this country, this Order shall at no time take part in strikes, nor in any way interfere between employer and employees. Recognizing their identity of interests, it shall take no part in any project or enterprise that shall interfere with perfect harmony between them; neither shall it be used for political or religious purposes.

These principles shall not be amended or repealed except by unanimous vote of the Order.

Any member who shall be guilty of violating the principles of the Order shall be expelled.

OBJECTS.

First.—To promote a more thorough knowledge in its members of theoretical and practical steam engineering.

Second.—To assist members to obtain employment.

Third.—To help the sick, injured and distressed and bury the dead.

Fourth.—To establish a Widows' and Orphans' Fund.

Fifth.—To help members who shall become incapacitated from following the profession to obtain employment suited to their affliction.

Sixth.—To do our utmost to extend the license law throughout the United States.

Seventh.—To establish schools in which our members may study the highest branches of steam engineering.

MEMBERSHIP.

An applicant for membership must be an engineer between twenty-one and fifty years of age, and must be a white male citizen of the United States, of good moral character and be a believer in the Supreme Being, and be free from all physical infirmities.

He must have had three years' service in an engineering department, or if a machinist, or graduate of a technical institute, then, one year's service, in such department, and in localties where engineers are required by law to be licensed, they must have such license, and must satisfy the investigating and examining committees of the council to which he applies as to his character and ability.

LIFE MEMBERSHIP.

Engineers who have passed the age limit may be admitted to life membership. They must possess the same qualifications and pass the same examination as are required in the next proceeding clause: They shall be entitled to all rights and privileges of the Order except they cannot vote on financial questions or for the election of officers or be entitled to any sick or death benefits.

DIRECTORY.

The Publication Committee of "The Practical Engineer" desires that the Corresponding Engineers of all Councils of the American Order of Steam Engineers send the name of their Chief Engineer and their own name and address, together with the time and place of meeting to the Secretary of the Publication Committee immediately after each election of officers. Address J. C. McDowell, Secretary, in care of "The Practical Engineer," 1215 Filbert Street, Philadelphia.

SUPREME COUNCIL OF THE UNITED STATES

Supreme Chief Engineer.—Clifford P. Williams, 528 Greenwich St. Phila.

Supreme First Assistant Engineer.—Noah A. Pierson, Fidelity Building, Baltimore, Md.

Supreme Recording Engineer.—Jas. H. Stallings, 3032 Dillon Street, Baltimore, Md.

Supreme Corresponding Engineer.—J. C. McDowell, 1913 South Eighth St., Philadelphia.

Supreme Treasurer Engineer.—Geo. W. Richardson, 3728 Manazambe St., Wissahickon, Phila.

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Supreme Junior Master Mechanic.—Joseph T. Harris, 1611 Clybourn St., Milwaukee, Wis.

Supreme Inside Sentinel.—D. J. Stayton, 1613 West 4th St., Wilmington, Del.

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DELAWARE.

Deputy Supreme Chief Engineer, David J. Stayton, No. 1613 West 4th St., Wilmington.

Wilmington.

Delaware, Council, No. 1, meets every Wednesday at S. E. Cor. Fourth and King Streets. Chief Engineer, W. D. Wyatt. Corresponding Engineer, A. E. Deakyne, 406 Lombard Street.

LOUISIANA.

Deputy Supreme Chief Engineer, John W. Angers.

New Iberia.

Evangeline Council. Chief Engineer, John B. Lanaier. Corresponding Engineer, W. J. Maynard.

MARYLAND.

Baltimore.

Deputy Supreme Chief Engineer, A. J. Deidrich, 226 North Caroline St., Baltimore, Md.

Maryland Council, No. 1, meets 2d and 4th Fridays in Royal Arcanium Hall. Chief Engineer, J. C. W. Schrier. Corresponding Engineer, Wm. S. Smith, 116 W. Lee Street.

Energy Council, No. 2, meets every Wednesday of each month in Bauer Hall, Cheaspeak and Elliott Sts. Chief Engineer, Philip A. Kirkwood. Corresponding Engineer, Jos. H. Stallings 3032 Dillon St.

MASSACHUSETTS.

Deputy Supreme Chief for Eastern District, W. E. Packard, Whitmann.

Boston.

Boston Council, No. 4, meets 2d and 4th Thursday of each month in Templar Hall, 724 Washington Street. Chief Engineer, Harry G. Black. Corresponding Engineer, Wm. T. A. Faulkner, 41 Worcester St.

Orange.

Orange Council, No. 9, Meets 2d and 4th Fridays. Chief Engineer, Chas. Gartrell; Corresponding Engineer, Fred. L. Hale.

Rockland.

Old Colony Council, No. 14, meets second and fourth Saturdays in the American Foresters' Hall. Chief Engineer, E. H. Naylor. Corresponding Engineer, James K. Sedgwick P. O. Box, 333, Rockland, Mass.

NEW JERSEY.

Deputy Supreme Chief, F. O. Garrison, Bridgeton, N. J.

Perth Amboy.

Stevens Council, No. 1, meets third Saturday, at Water, near Lafayette Street. Chief Engineer, Lawrence Oliver. Corresponding Engineer, James H. White.

Camden.

Camden Council, No. 8, meets every Thursday evening at N. E. corner 2d and Federal Street. Chief Engineer, S. R. Middleton. Corresponding Engineer, C. H. Pfeiffer, 571 Berkley St.

Atlantic City.

Atlantic City No. 4 meets every Tuesday evening at Merchants, Cor. Atlantic and New York Avenues. Chief Engineer, R. Endicott. Corresponding Engineer, W. S. Price, Haddon Hall.

Bridgeton.

Bridgeton Council, No. 5, meets every Friday. Chief Engineer, David Sellers. Corresponding Engineer, Francis O. Garrison, Bridgeton, N. J.

Millville.

Millville Council, No. 6, meets every Saturday, 7.30 p. m., in G. A. R. Hall, East Main St. Chief Engineer, Geo. Esabel Corresponding Engineer, Lewis Doughty, 604 Mulberry Street.

NEW YORK.

Syracuse.

John E. Sweet Council, No. 6, meets Monday, Room 23, Nottingham Block, East Washington Street. Chief Engineer, John Cunningham. Corresponding Engineer, S. A. Steel, 311 Orange street.

PENNSYLVANIA.

Grand Chief Engineer, Hiram Trout, 1105 North Tenth street, Reading, Pa. Grand Corresponding Engineer, Frederick Markoe, 931 Orianna street, Philadelphia.

Philadelphia.

Germantown Council No. 22 meets every Wednesday evening at Beatties Wayne Junction Hall, Wayne Junction; Chief Engineer, John P. Rickards; Corresponding Engineer, Frank MacIndre, 3529 Ainsley St., Falls of Schuylkill, Philadelphia.

Welcome Council, No. 2, meets every Friday, N. W. Cor. 12th Street and Columbia Avenue. Chief Engineer, Paul Pieling. Corresponding Engineer, L. D. Woodington, 2428 N. Bancroft St.

Kensington Council, No. 3, meets every Thursday, at A. P. A. Hall, Frankford Avenue and Master Street. Chief Engineer Wm. C. Stolt. Corresponding Engineer, Charles Fournier, 3115 Richmond St., Philadelphia.

Southwark Council, No. 4, meets every Monday, at corner of Reed and Eighth Streets. Chief Engineer, Walter Sommers. Corresponding Engineer, J. C. McDowell, 1913 S. 8th Street.

(Continued on page 28.)

BOILER SCALE

Its Removal; and Reformation Prevented.

TRADE MARK

Did you ever stop to consider that your boiler was not giving the same results as when first installed or that a 1-16th inch scale in your boilers will increase your fuel bill 13 per cent.; a 3-8 inch 50 per cent.? This is not theory; but demonstrated facts. Tests have proven that there is only one way to overcome these conditions, i.e.

BY THE USE OF KEYSTONE TRI-SODIUM PHOSPHATE

AND BOILER COMPOUNDS.

Absolutely guaranteed not only to prevent scale and corrosion, but to remove that which now exists, without injury to the boiler.

REGISTERED

FULLY INDORSED BY THE STEAM BOILER INSURANCE COMPANIES. Our Booklet "Worth Knowing" explains more fully. Free

Keystone Chemical Manufacturing Co. CAMDEN, N. J.

Garlock's Standard High Grade Packings

STYLE No. 99

GARLOCK
WATER PROOF RING
HYDRAULIC PACKING
(For Cold Water Only.)

This packing has been demonstrated to be first-class Cold Water Packing by very practical and severe tests on the water ends of pistons, plungers, hydraulic elevators, etc.

It is made of the best flax and lubricated with a superior waterproof compound strictly free from acid. We furnish this packing in either coil, spiral or ring form.

GARLOCK
Special Hydraulic Ring Packing for Pump Cylinders
(Especially Adapted for Hot Water)

STYLE No. 260

Our special hydraulic rings have the advantage of being made a *perfect* fit, and are without a joint. Can be readily split to exactly fill the depth.

Our many customers are all pleased with the results. Sizes must be *exactly* to 1-64 of an inch, as the rings are very rigid.

We are also manufacturers of a general line of standard packings for all purposes

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Send for Catalogue and Samples to our Nearest Office

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NONE GENUINE WITHOUT IT
TRADE Garlock MARK

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Main Offices and Factories

PALMYRA, N. Y.

A Hard Pull

With solid packings gripping the piston-rod, an engine has a hard pull to overcome this friction before it does a stroke of its proper work.

DANIEL'S "P.P.P." PACKING

prevents all this needless friction and waste of fuel. Its sliding wedges adjust themselves to the rod with the least possible friction, saving power, fuel, packing, labor and trouble to the engineer.

Try it, and see if you can save coal for the boss without his finding it out.

Mr C. M. Johnson, chief engineer, Enterprise Box and Lumber Co., Milwaukee, says:—"I have not been able to run the best brands of packing over three months. Your "P. P. P." has stood one year. It is a great economizer in steam."

Get it of your dealer.

FREE—Our patent steel packing rule saves engineers labor, time, trouble, temper, packing, burnt fingers and swear words. It is worth $1.00. Sent absolutely FREE to engineers who order from us enough "P. P. P." for a trial, if they mention this paper.

MANUFACTURED ONLY BY

QUAKER CITY RUBBER CO.

PHILADELPHIA

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DIRECTORY OF COUNCILS CONTINUED.

Philadelphia Council, No. 7, meets every Wednesday. at Kenny's Hall, N. W. cor. Broad and Filbert Sts. Chief Engineer, Ole Hanson. Corresponding Engineer. W. S. Wetzler, 3707 Aspen St.

Manayunk Council, No. 9, meets second and fourth Friday evenings in Temperance Hall. Chief Engineer, Richard Wallace. Corresponding Engineer, John Clevenger, 211 Lofty Street.

Helping Hand Council, No. 12, meets every Tuesday evening at Jasper and Huntington Streets. Chief Engineer, Thos. Evans. Corresponding Engineer, Frank McHugh, 2503 Tulip St.

Municipal P. F. D. Council, No. 20, of Philadelphia, meets the second Thursday of each month at Odd Fellows' Hall, Third and Brown Streets. Chief Engineer, Frederick Markoe. Corresponding Engineer, Walter Meyers, 1211 North Howard Street.

Pittsburg.

Iron City Council No. 21 meets every Saturday at 1070 Fifth Avenue. Chief Engineer, M. J. O'Sullivan. Corresponding Engineer, John Mc. F. Easton, 127 Yard Street, S. S.

Girardville.

Girard Council, No. 8, meets every Tuesday evening at O'Neill's Hall, 2nd and Ogden Sts. Chief Engineer, Jacob Weber. Corresponding Engineer, M. J. Carey, Lock Box 214.

Allentown.

Lehigh Council, No. 15, meets every Wednesday evening at 639 Hamilton St. Chief Engineer, Jacob Donnecker. Corresponding Engineer, A. P. Driesbach, 728 Chew Street.

Pottstown.

Pottstown Council, No. 14, meets first and third Saturday evening at P. O. S. of A. Hall. corner High and Hanover Sts. Chief Engineer, Joseph Rhoads, Corres., Engineer, H. L. Shirey, 392 Cherry St.

Reading.

Progress Council, No. 13, meets every Saturday evening at Diebert Hall, 9th and Penn Sts., Room 4. Chief Engineer, Frank S. Miller. Corresponding Engineer, James M. Fisher, 1224 Oley St.

Chester.

Delaware County Council, No. 6, meets every Wednesday evening in the Carpenter Hall, 6th and Wall St. Chief Engineer, John Canavan. Corresponding Engineer, E. E. McCoy, 2222 West 3d Street.

York.

York Council, No. 16, meets every Wednesday evening in the Jordan Block. Chief Engineer, F. Seyler. Corresponding Engineer, Walter H. Long, 23 East Philadelphia Street.

Harrisburg.

Capitol City Council, No. 17, meets every Tuesday evening in Red Men's Hall, Market Street, above Second. Chief Engineer, B. H. Shafer. Corresponding Engineer, S. Filson, 1126 Market Street.

Columbia.

Columbia Council, No. 18, meets every first and third Saturdays, in Bittner's Hall. Chief Engineer, R. K. Grosh. Corresponding Engineer, W. J. Courtney, 804 Walnut Street.

Sunbury.

Sunbury Council, No. 19, meets every second and fourth Thursday in Zartman's Hall. Chief Engineer, Aaron Buck. Corresponding Engineer, Ed. Schrieber.

WISCONSIN.

Deputy Supreme Chief Engineer, Joseph P. Harris, No. 1611 Clybourn Street, Milwaukee.

Milwaukee.

Washington Council, No. 1, meets every Saturday at 207 Grand Avenue. Chief Engineer, J. B. Chambers. Corresponding Engineer, James A. Rigby, 136 Reed Street.

Clifford P. Williams Council, No. 2, meets every Thursday evening 298 4th Street. Chief Engineer, David T. Richardson. Corresponding Engineer, Jas. T. Harris, 1611 Clybourn Street.

TENNESSEE.

Deputy Supreme Chief Engineer, John B. Mullen, 826 Central Ave., Nashville.

Nashville.

Enterprise Council, No. 1. meets every Friday evening in the Twin Building on Cedar St. Chief Engineer, J. J. Johnson. Corresponding Engineer, Jno. B. Mullen, 209 Jackson Building.

OREGON.

Deputy Supreme Chief Engineer, Benjamin F. Myrick, P. O. Box No. 1. Grant's Pass, Oregon.

Grant's Pass.

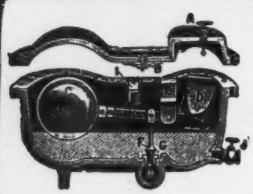
Oregon Council No. 1. Chief Engineer, William H. Kenny. Corresponding Engineer, Benj. F. Myrick, P. O. Box No. 1. Meets every first and third Saturday. A. O. U. W Hall Main St.

TEXAS.

Deputy Supreme Chief Engineer. S. A. Bishery care of Cotton Compress and Warehouse Co., Galveston.

Galveston.

Galveston Council No. 1 meets every second and fourth Tuesday evening at Engineers Hall, So. West corner 22nd and Strand Streets Chief Engineer, Max Levy; Corresponding Engineer, A. L. Bradford, Union Depot.



McDaniel Steam Traps

Always have a Water Seal over the valve and never blow steam; neither do they back up water

REDUCING VALVES
EXHAUST PIPE HEADS,
EJECTORS, RELIEF VALVES,
GREASE EXTRACTORS,
STEAM SEPARATORS, etc.

Watson & McDaniel Co.

MANUFACTURERS

Send for 1902 Catalogue

147 N. Seventh Street

For sale by the Jobbing Trade

CRANE VALVES
ESTABLISHED 1855

RED SEAL BOILER COMPOUND...

RED SEAL BOILER COMPOUND

WILL REMOVE SCALE, GREASE AND DIRT FROM STEAM BOILERS - - -

Saves fuel; purifies the water; prolongs the life of the boiler; prepares the water to make pure steam. Its action on old scale is gradual but certain. Prevents grooving, pitting and wasting of iron. Does not injure or corrode the iron. Contains no acids.

Manufactured by

THE CHERRY CHEMICAL CO.

OFFICE: 1215 FILBERT ST., PHILADELPHIA, PENNA.

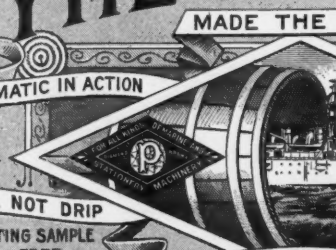
Circulars, Prices and Directions Furnished on Application.

THE PULVER

MADE THE BEST

AUTOMATIC IN ACTION

QUALITY NEVER CHANGES



WILL NOT DRIP

WILL NOT FREEZE

TESTING SAMPLE FREE.

SEND FOR CATALOGUE.

WORKS THE BEST IS THE BEST

214 FRANKLIN ST., N.Y.

LUBRICATING COMPOUND

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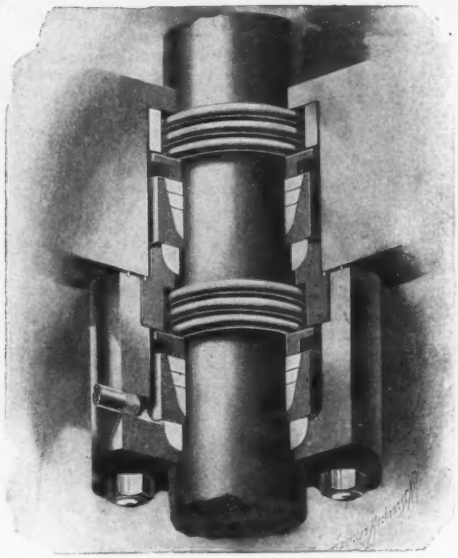

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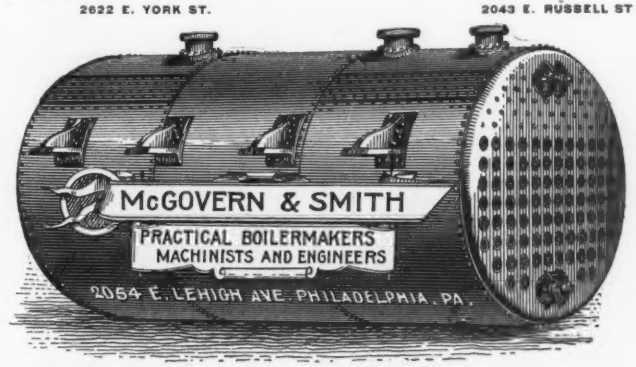

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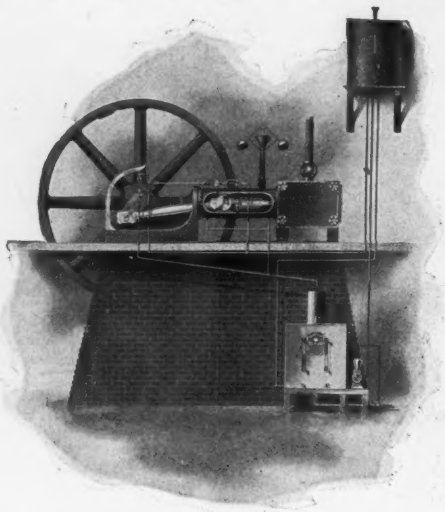

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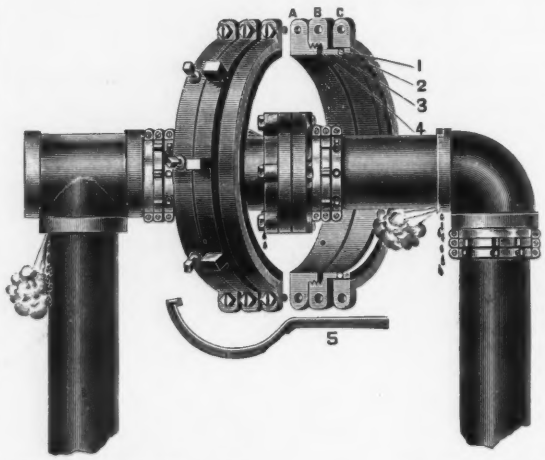

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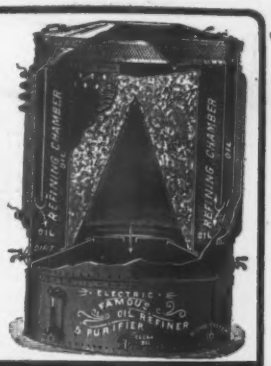

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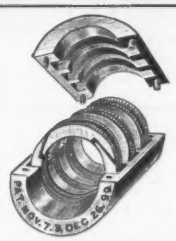

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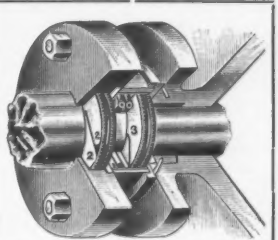

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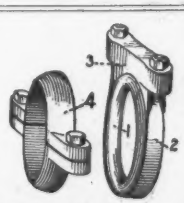

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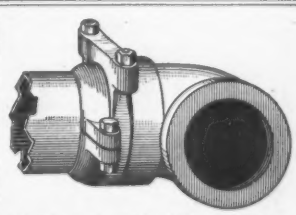

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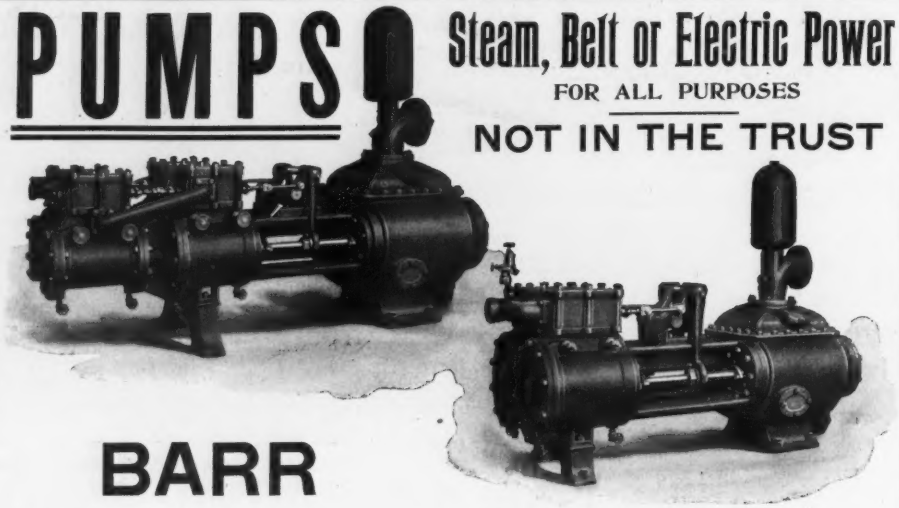

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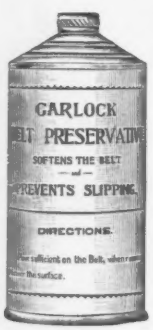

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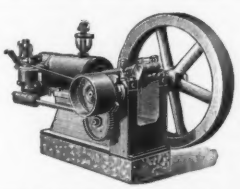

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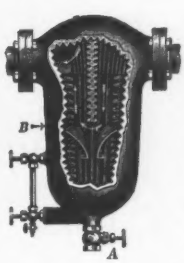

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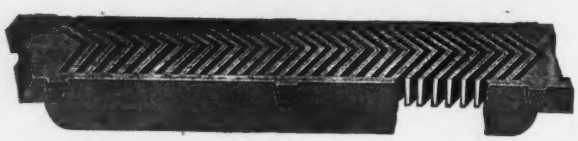

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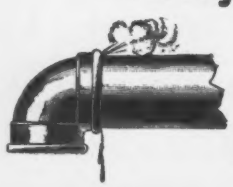

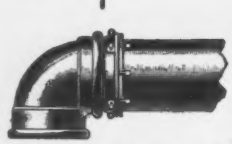

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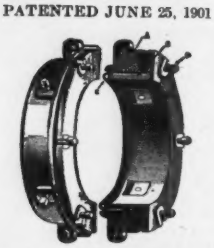

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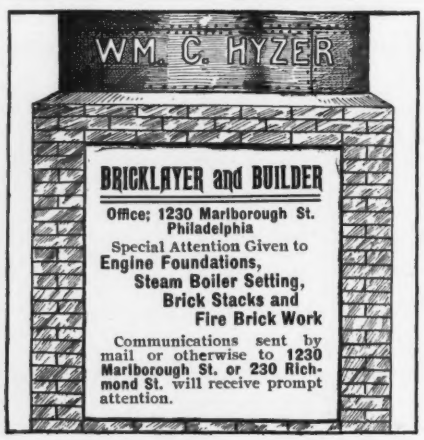
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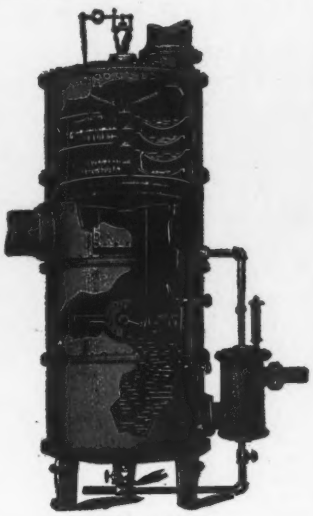

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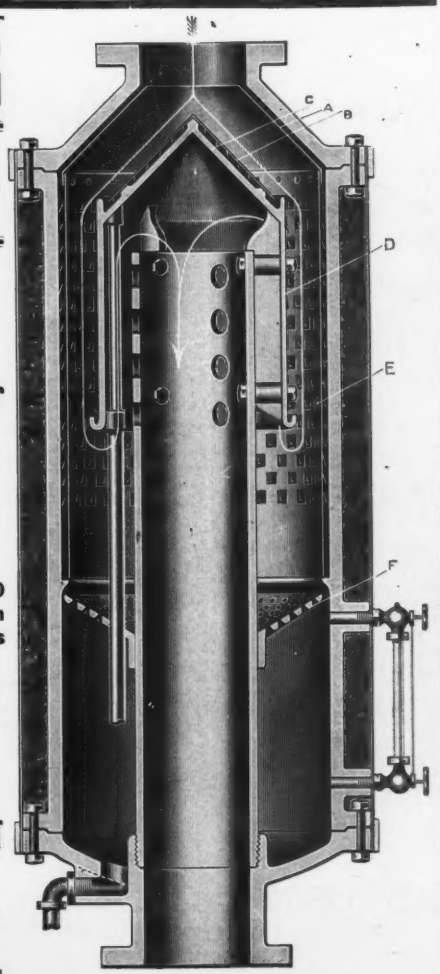

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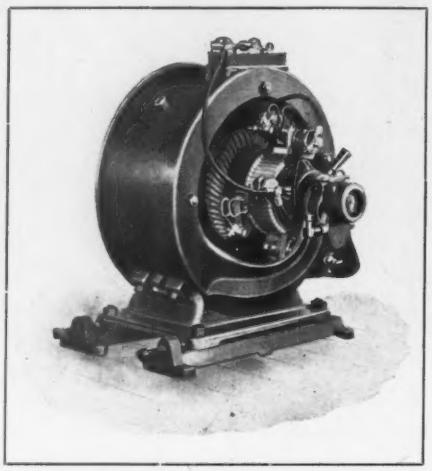

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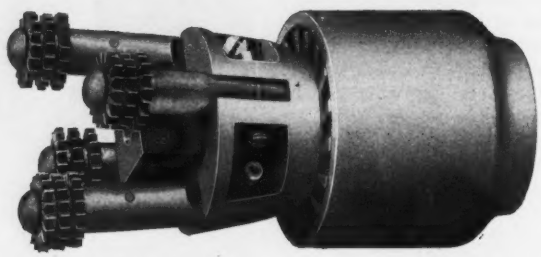

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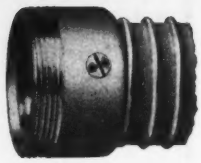

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But are you troubled with mud, scale, pitting, or other boiler ills? Of course you are. Well, we can stop that trouble for you at a price that will astonish you.

We do not say try this and it will help you, but we agree to remove your old scales and prevent the formation of any new. The first cost is the last cost. We remove the scale forming matter from the boiler automatically, and we reach it at the only point it can be reached—the steaming point IN the boiler.

WE WILL DEMONSTRATE OUR ABILITY TO RELIEVE YOU FREE OF COST. LET US EXPLAIN FURTHER.

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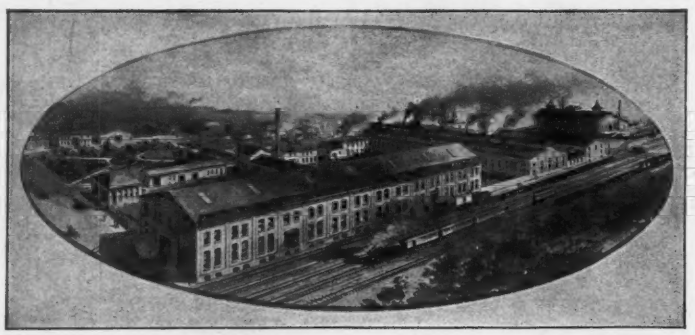

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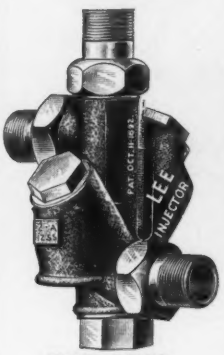

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made either with **Rubber or Canvas Core** and both **Round** and **Square** in shape. Will give satisfaction on Engine, Pump, Compressor and Valve Rods. Easiest of all packings on your rods.

Brandt's Triple Expansion Gaskets

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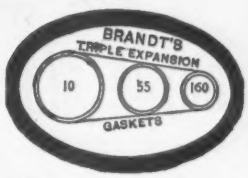

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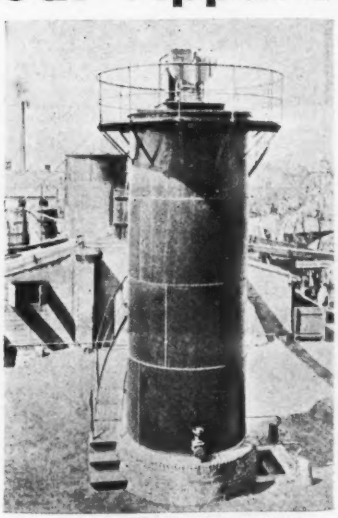

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All Sizes, from 10 HP up

Removes all scale forming matters, acids, mud, etc.

Is economical, both in installation and operation.

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Minimizes repairs and coal bills.

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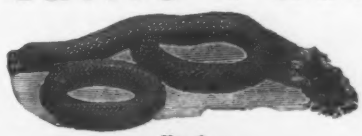
Metallic Packing

for Stuffing Boxes of Piston Rods Valve Rods and Other Reciprocating or Rotating Parts of Machines Requiring Packing Never Melts Burns or Decays Saves Oil Reduces Friction Protects Machinery Will Stand Any Pressure And is Practically Indestructible



No. 1

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Holds No Moisture Consequently It Will Not Pit or Mark the Rod When Engine or Pump Is Idle

Illustrated Explanatory Circular and References on Application

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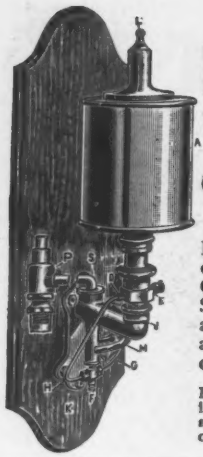

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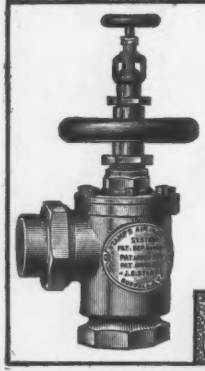

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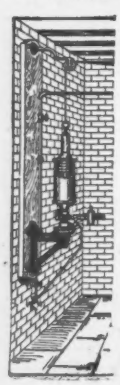

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If you can't see into it through the cut, I will send you one or more

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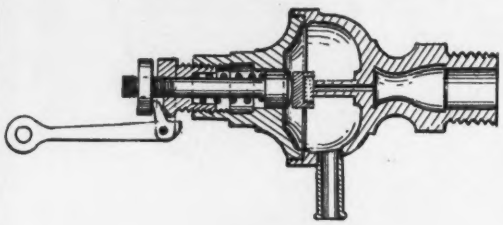
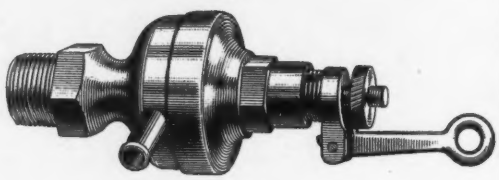
To be returned at my expense if not better than any gauge cock that you ever used



Sectional View



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DOES NOT DRIP

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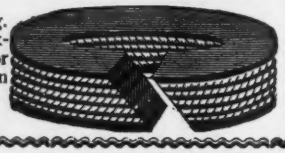
Self-lubricating, Steam and Water Tight, Less Friction than any other known packing. **None Genuine Without This Trade Mark Stamped on Wrapper.** All similar packings are imitations. In ordering give exact diameter of Stuffing Box and Piston Rod or Valve Stem. Our Packing is a sure cure for leaky stuffing boxes, whether the motion is rotary or reciprocating.



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Vacuum Valve for Condensing Plants

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Some Specialties: *Pump Governors, Reducing Valves, Back Pressure Valves, Condensing Engine Relief Valves, Heavy Duty Valves, Damper Regulators, Steam and Water Separators, Receivers for Returning Condensation, Thermostat Controllers, Water Works Reducing and Relief Valves. Water Filters, Remove all Sediment.*

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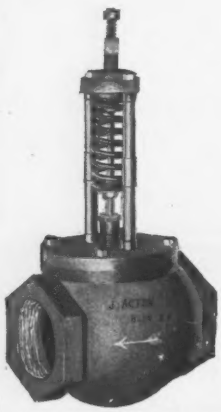

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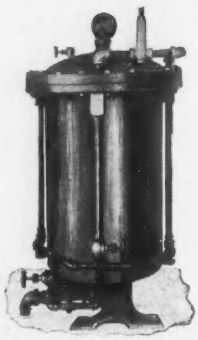

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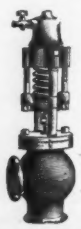
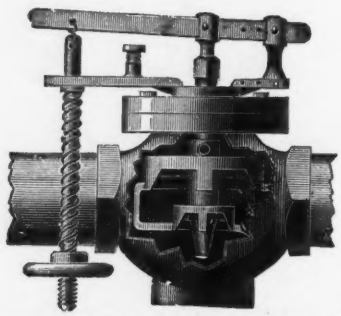


Pump Governor



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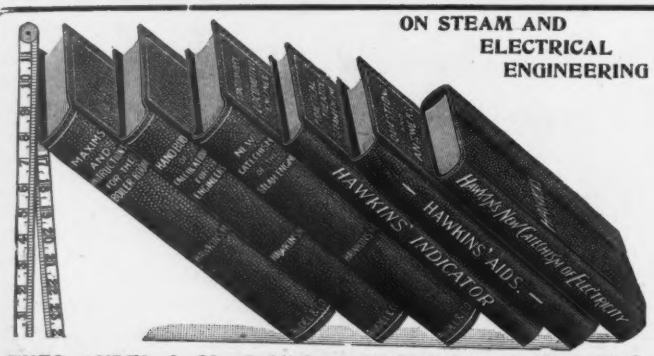

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The time you give for inspection will not be lost either, to yourself or the interest you serve.

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Respectfully,

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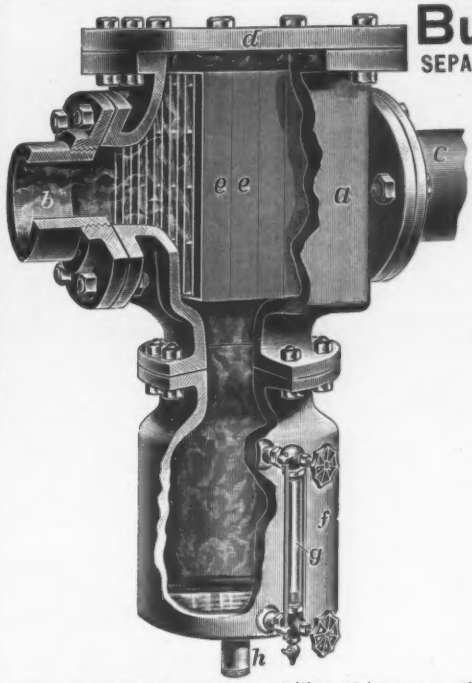

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The Operating Engineer, the man who stands by the throttle day after day, is the man that knows whether an Engine is good or bad

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Thanking you in advance, I remain

Respectfully yours,

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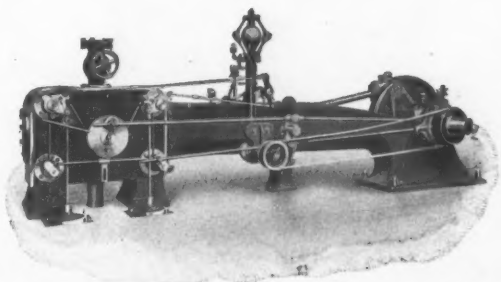

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CATALOGUES FOR THE ASKING

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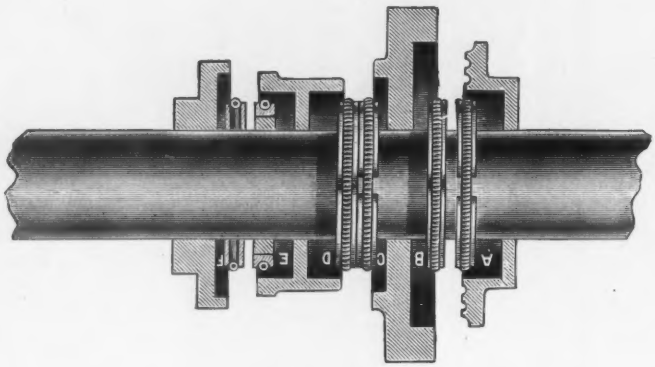

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NO FRICTION NO ATTENTION A GAIN OF POWER

A Look at the Piston Rods will Convince the Most Skeptical
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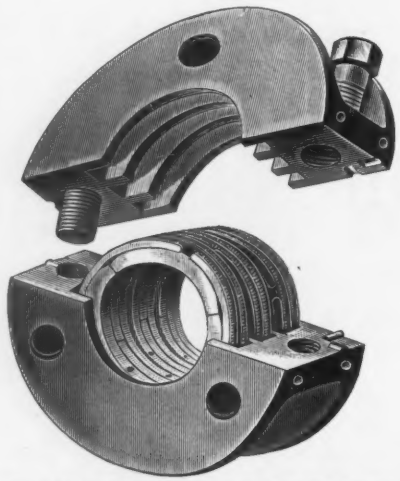

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40 Per Cent Saved

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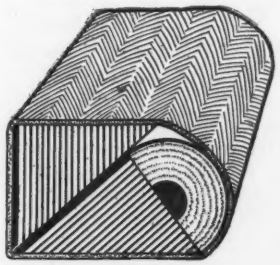

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MADE IN 12-FOOT LENGTHS OR
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TO FIT YOUR RODS

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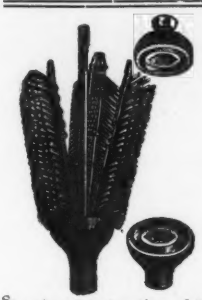
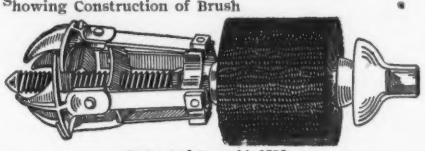


Showing Construction of Brush



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It Is Guaranteed Not to Break, Being made of Malleable Iron and Tempered Steel

It Cleans the Entire Flue Every Time it is Pushed Through

Brush ready for use

Keep your tubes clean and save money. **Pilley's Combination Flue Brush and Scraper** is the simplest and best cleaner on the market. A simple turn of the hand adjusts it to the tube and the brush removes what the scraper loosens. Guaranteed not to break nor the wires to come out or lay over. Sizes from 2 inches up. Measure outside diameter of tube.

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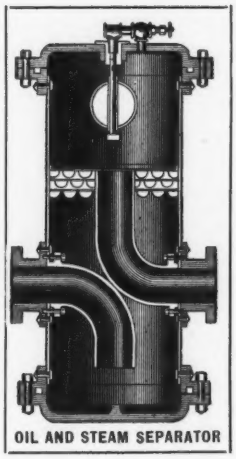
The LINDSTROM Steam and Oil Separators



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Will keep the water in your Boiler.
Will reduce the moisture ¾ of 1 per cent.
Will stop the priming in your boiler.
Impossible to get water over to Engine from Boiler.

It pays to remove the Oil from Exhaust Steam.

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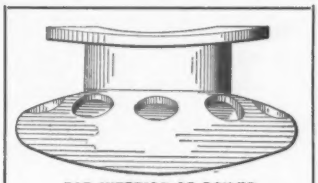
Cylinders Re-bored in their present positions. From 4 inches to 70 inches.

ALL KINDS OF STEAM ENGINE AND STEAM PUMP REPAIRS. GENERAL AND SPECIAL HIGH GRADE MACHINE WORK.



FOR INTERIOR OF BOILER

SEND FOR PARTICULARS AND PRICES

John T. Lindstrom

440 Liberty Street - - - Allentown, Penna.

HOUGHTON'S MONTHLY LETTER TO ENGINEERS

DEAR MR. ENGINEER:

In June number of the PRACTICAL ENGINEER, the following advertisement appeared:

"If the "Heintz" Steam Trap was not the best, it would not be the oldest, other traps would have replaced it.

"But look out for the name, imitations sometimes fool the best of us. One firm took up a trap that looked like the "Heintz", handled it for a year or two until the people found there was a difference and began to look for the name, then dropped it and took up another about which they are telling the same alluring stories that they told about the first one.

"The "Heintz" was first, it is best, and it will be with you when the others have gone where the woodbine twineth."

As we are the only firm in America that has sold two makes of traps to which the "Heintz" is similar, this advertisement must have referred to ourselves.

The information which the advertisement attempts to convey is that we abandoned the sale of the Sirius Trap and took up the sale of the Marck Trap, because the Sirius Trap was a failure. Such is not the case.

The Sirius Trap was such a success that the works could not fill our orders, and after spending a lot of money in advertising and selling expenses, we could not reap the benefit therefrom, because we did not have the traps in stock, nor could we obtain them.

Consequently, we made an arrangement by which this difficulty would not occur, and it was owing to the phenomenal success we made with the Sirius Trap, that we were enabled to withdraw it in favor of the Marck.

The Sirius Traps are to-day working in thousands of places; are giving the very best of satisfaction; were sold under a guarantee; and most of our customers who have purchased Sirius Traps have also purchased Marck Traps.

We are just as particular to impress upon the public that the Marck Trap is not the "Heintz Trap" as the selling agents for the Heintz Trap appear to be.

As the object of the advertisement of the Heintz Trap in June number of PRACTICAL ENGINEER was to get rid of our competition, we can only remind the readers of the PRACTICAL ENGINEER, that we have on several occasions offered to entirely withdraw from the trap business, go out of the business entirely, if Wm. S. Haines Co., would prove before any intelligent body of engineers or experts, that their claims for superiority were correct.

These offers have been entirely ignored by Wm. S. Haines Co.

However, we prefer to say pleasant things about our competitors, and we can only say here, that the Heintz Trap is a good trap, and the Marck Trap is a better trap.

We have been more successful with the Marck, perhaps, because we know how to advertise and sell traps better; because, after all is said and done, the difference in favor of the Marck Trap is only the small detail, such as quick working, working at a temperature above 150 pounds pressure, and general better workmanship.

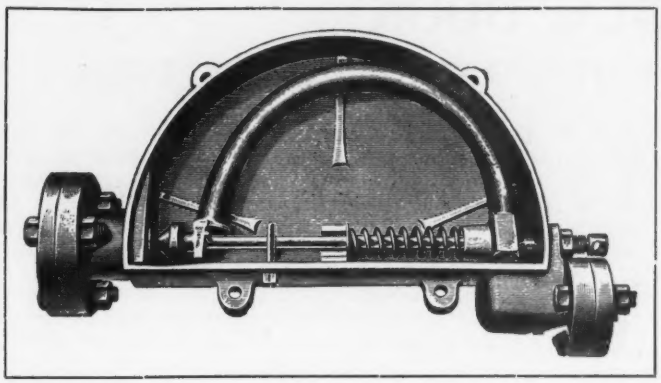
Anyone who buys a Heintz Trap will get the worth of his money. Anyone who buys a Marck Trap will get more.

Yours very respectfully,

E. F. HOUGHTON & CO.

240-250 W. SOMERSET STREET PHILADELPHIA

175-177 LAKE STREET CHICAGO



The coal you don't burn

is clean, clear profit. You double that profit the day you put the Heintz Steam Saver in your plant.

It saves two tons where other traps save one, and still it saves, when other traps are done.

THE HEINTZ STEAM SAVER

only wants a chance to get its nose inside your door, like the camel in the story; it will take care of the rest. For example, Mr. G. M. Brill, the well-known car-builder, said at first, "There isn't a place in our establishment where we could use your trap." All the same, he is now using over **one hundred** of them in that same establishment. As soon as people find out what one of the Heintz Savers saves, they soon find places for more. Look out for imitations.

The Heintz Steam Saver is made in nine sizes, capacity one quart to 240 gallons a minute. Any size sent on 30 days trial; no charge unless satisfactory. Guaranteed for one year.

WILLIAM S. HAINES COMPANY

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HAS THE

Highest Efficiency for Keeping in the COLD or HEAT

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THE STEAM ENGINE INDICATOR and ITS APPLIANCES

A COMPREHENSIVE TREATISE FOR THE USE OF CONSTRUCTING, ERECTING AND OPERATING ENGINEERS, SUPERINTENDENTS, MASTER MECHANICS, STUDENTS, ETC.

Describing in a clear and concise manner the practical application and use of the steam engine indicator, with many illustrations, rules, tables and examples for obtaining the best results in the economical operation of all classes of steam, gas and ammonia engines, together with **original and correct information on the Adjustment of Valves and Valve Motion, Computing Horse Power of Diagrams,** and extended instructions for attaching the indicator. Its correct use, management and care, derived from the author's practical and professional experience, extending over many years, in the construction and use of steam engine indicator.

BY WILLIAM HOUGHTALING

320 PAGES. 157 ENGRAVINGS. 20 FULL PAGE TABLES

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PREFACE

The preparation of this book has occupied most of the author's spare time for a number of years. Originally the matter was not intended for publication, but the manuscript has grown so large and complete, which consideration, combined with many repeated requests, has induced the writer to publish the matter in book form.

Let every engineer make his own indicator book as he proceeds in his study and practice, and it will prove invaluable in after years. The present work has been compiled in this way, from data continually obtained during the author's professional career, extending over a third of a century.

The introduction of algebrical formules have been avoided. These are readily found in the many valuable mechanical pocket books. The writer has endeavored to discuss the principle and use of the indicator in as plain common sense words as the subject and the English language will admit of

Special attention has been given to the requirements of the young progressive student in steam engineering. The preparation of the following chapters has been a work of pleasure to the author, and if they prove beneficial to his fellow-workmen, he will be amply repaid.

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Publishers, Booksellers and Importers - - Bridgeport, Conn., U. S. A.

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for a piece of scale from your boiler. Ask him how much coal you would save if your boiler was absolutely free from Scale.
He will tell you that this saving will amount to considerable.
Send the scale to us and we will make an analysis; send your certificate of same and a full report.

THIS WILL COST YOU NOTHING

Even if you should place an order with us, the Compound would cost you nothing, as the saving in fuel will more than cover the outlay.
Write now.

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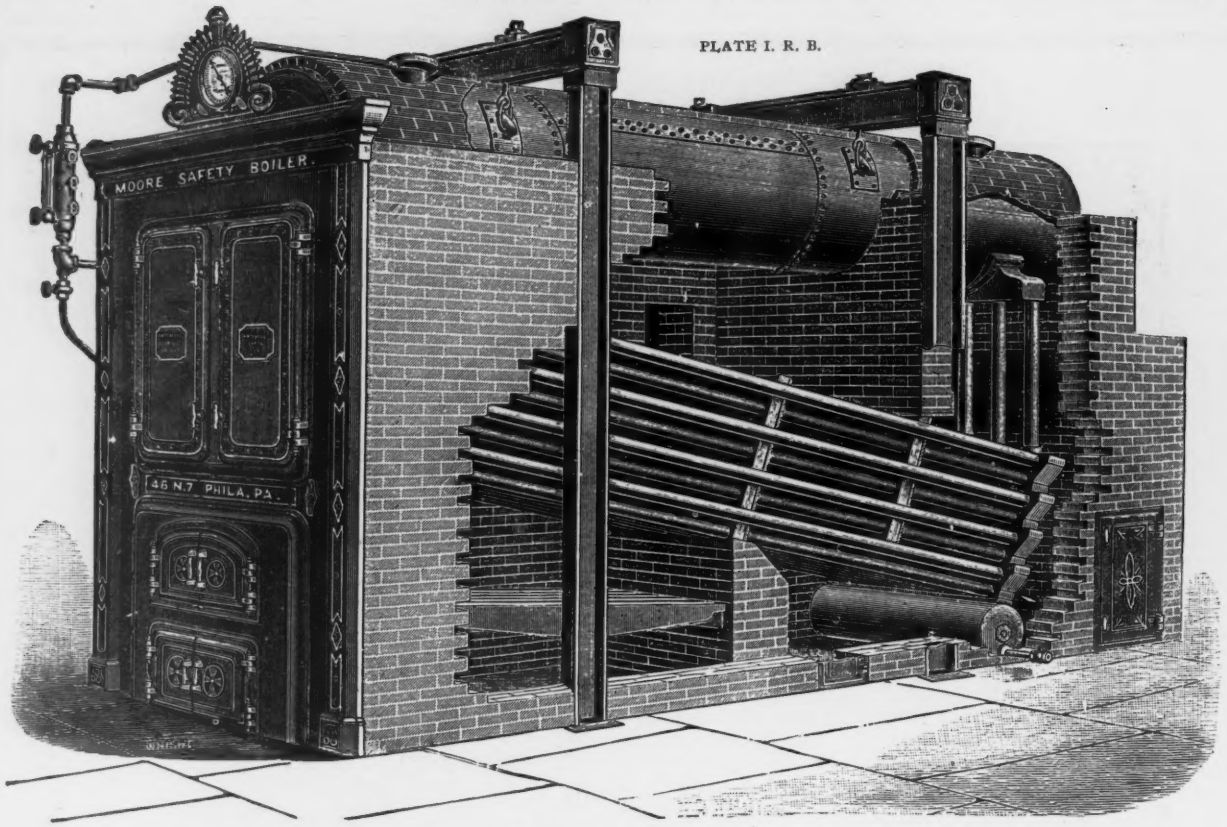

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Repairs of Water Tubes. Boilers of all types a specialty. We have special tools for this purpose. TELEPHONE 1-55-82-A
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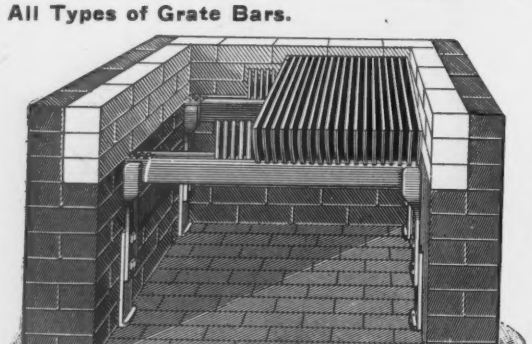

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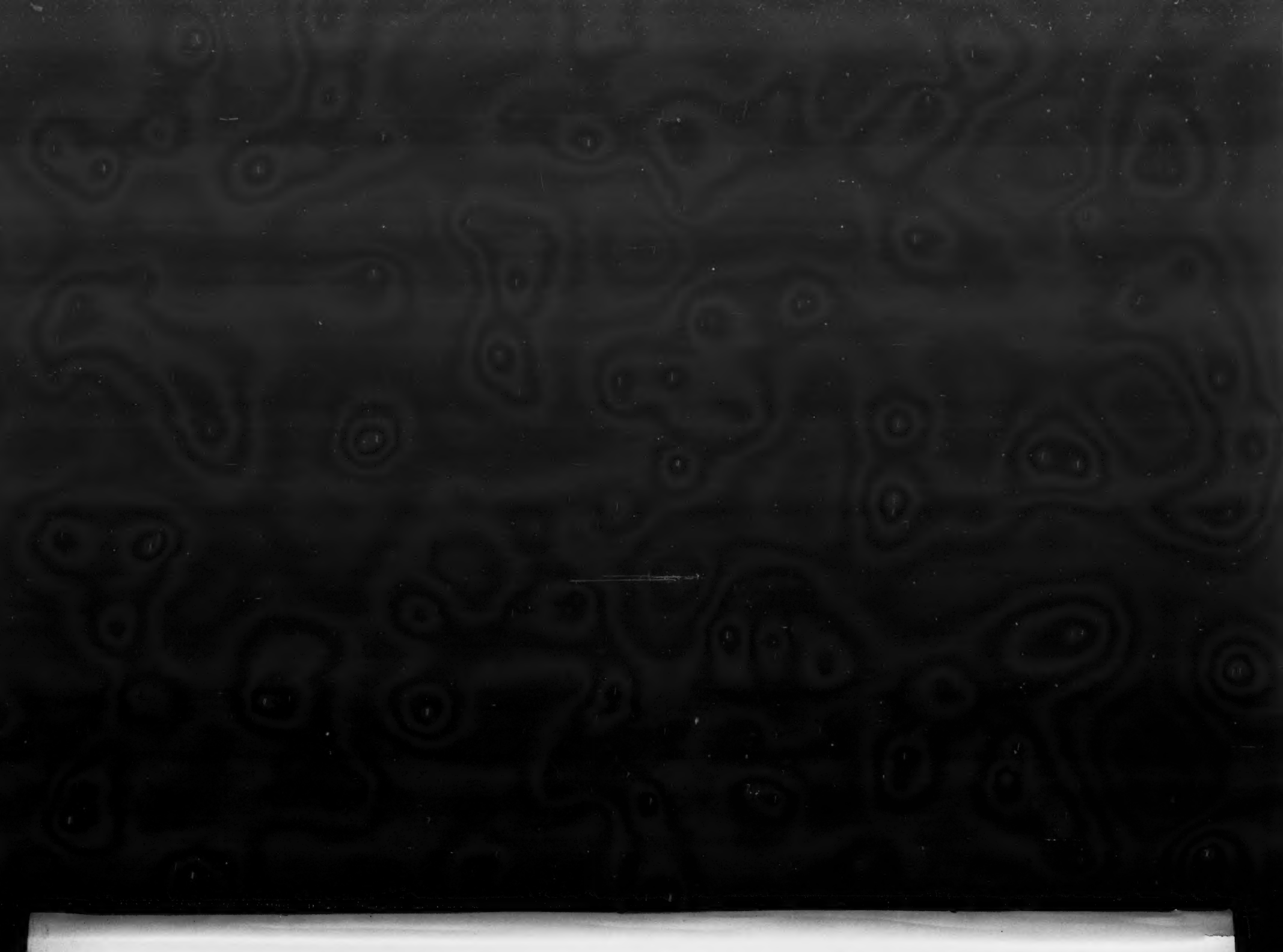

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and the general verdict is that

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are the only old and original goods now offered to the trade, and that PERRY'S SPECIALTIES in Steam Packings, for all purposes, are made upon honor and have no superiors.

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Made of Gun Metal, are unsurpassed where thorough, reliable service is the first requisite. In screw and flange ends for 200 and 350 lbs. working pressure, ⅛ inch up. A trial order demonstrates their peculiar fitness and invariably results in their adoption. These valves are extensively used and in continuous service in the United States Navy, locomotives, lake and river boats high-pressure power plants, etc. **Specify Lunkenheimer Make**

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is made from a compound somewhat similar to the Jenkins '96 Packing. It is suitable for steam joints, hand holes and man holes. It is handy and economical, and is giving the best of satisfaction. It is made ⅜", ½", ⅝" and ¾" in diameter in lengths of about 12 ft. Packed in boxes weighing 4 to 6 pounds.

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We make valves adapted for all conditions of service. It is our constant aim to produce the best, regardless of cost. Like all our specialties, they are guaranteed to give entire satisfaction. When ordering, state diameter, thickness and size of hole; also in what service they are to be used.

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The universal popularity which these valves have attained is proof of their superior qualities. They give good service under the severest conditions. They are the only valves which have the **Jenkins Patent Keyed Stuffing Box,** which holds packing securely and prevents leakage around the spindle, and the **Jenkins Disc Removing Lock Nut,** which not only locks the disc nut, but assists in removing the disc when necessary for repairs. They can be packed when under pressure with valve wide open. The improved **Jenkins Disc** used in these valves is made in the most careful manner, and will stand high pressure steam, oils, acids, ammonia, etc. **Accept no Imitations.** Remember the genuine are always stamped with our Trade Mark, and are fully guaranteed.

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